AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Executive Office of the Society: Saint Joseph, Michigan.

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VOLUME 20 AUGUST 1939 NUMBER 8

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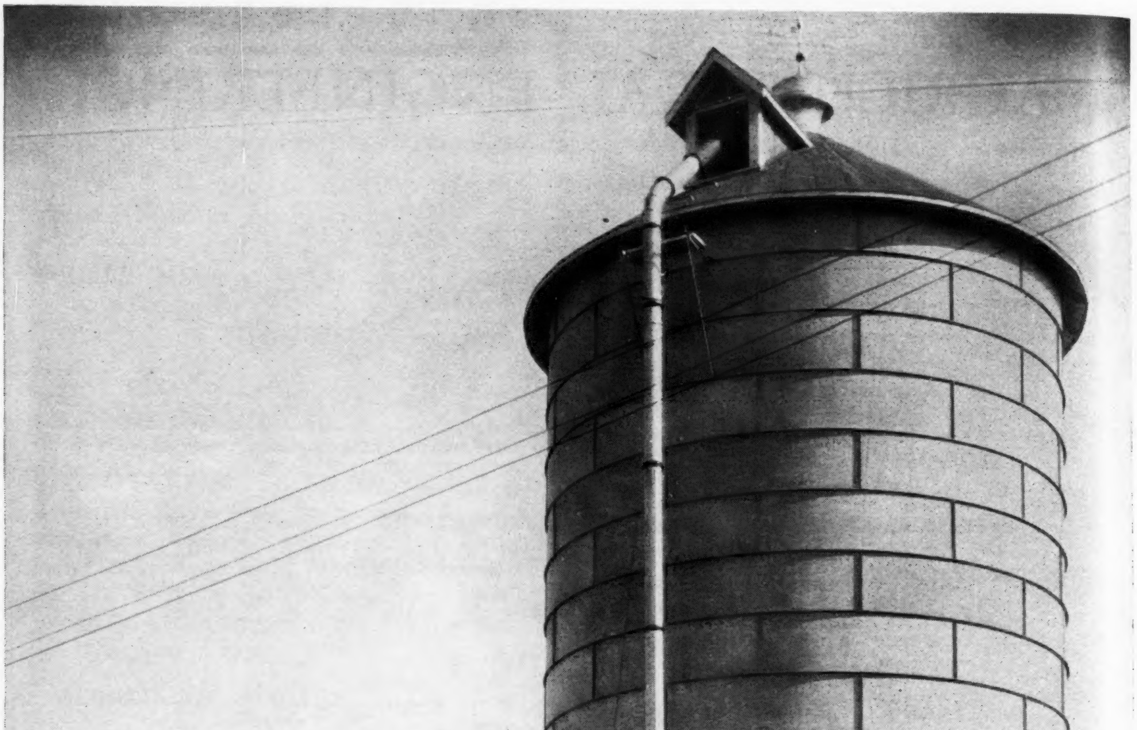
Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the executive office of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .



Engineering for Farm Chemical Functions

SILOS ARE the chemical vats of stock farms. They are structures engineered to meet specifications established by chemists to provide suitable conditions for biochemical reactions. Filling equipment and operations, too, are engineered to meet economically the specifications of chemists as to the physical preparation, mixing, placing, and packing of raw materials to effect the desired reactions and preservation of nutritive values. This is one example of collaboration between chemists and agricultural engineers to help farmers make the most of their production possibilities.

AGRICULTURAL ENGINEERING

VOL 20, NO 8 EDITORIALS AUGUST 1939

Chemistry and Agricultural Engineering

PROMISING future opportunities for agricultural engineering in the newly organized Bureau of Agricultural Chemistry and Engineering in the U. S. Department of Agriculture, was the keynote of the A.S.A.E. annual meeting address by Dr. Henry G. Knight, published elsewhere in this issue. We find some of his remarks particularly interesting and worthy of added emphasis.

Understanding leadership is indicated in Dr. Knight's concept of engineers and chemists as a "natural" team in fitness to work together for practical results. He believes that the teamwork which developed gunpowder and the guns in which to use it, and similar chemical-mechanical combinations in the history of civilization, can operate effectively in and for agriculture. He sees agriculture as an organic chemical industry subject to improvement in the variety, quality, and applications of the chemicals produced; and in the equipment, methods, controls, and organization for producing, handling, storing, processing, and using these chemicals. He acknowledges freely the engineering involved in the application of chemistry on farms and in processing farm products. Moreover, he has indicated a conviction that this engineering is essentially agricultural engineering.

It appears that under his leadership there will be opportunity for and insistence upon effective teamwork between chemists, agricultural engineers, and other specialists in working on farm problems which overrun man-made technical boundaries. Specialization will continue to be honored as a means of effectively applying man's limited individual capacity to the mastery of narrow fields of technology; but this specialized mastery of different fields of knowledge by different individuals is not to stand as a barrier to effective work on problems involving two or more fields of specialization. Functional organization and administration are to promote mutual understanding, respect, and coordination of effort and resources.

Another gratifying assurance is that fundamental research in chemistry and engineering is to be continued, and increased, to build up the scientific background on which sound applications may be based.

Agricultural engineers might act as agents of agriculture, seeking new and better outlets for farm products, and ways of improving farm products and decreasing their cost as industrial raw materials, Dr. Knight suggests. Industrial demand for raw materials is far from static. If farmers are to count on this market they must be prepared to meet competition and changing requirements. The mining, lumbering, petroleum, and fishing industries are strong competitors for important parts of the industrial raw materials market. Changes in processing may require either higher or lower quality of raw material, and changes in time, quantity, cost, and form or condition of delivery. Changes in demand for the finished products will alter requirements for raw materials. We are inclined to agree with Dr. Knight that agricultural engineers should help farmers adapt their production methods and costs to profit from new market opportunities and to meet changing requirements.

And looking at the matter from somewhat of a sales viewpoint, Dr. Knight says "Research on industrial utilization of farm commodities must make it as easy as possible for industry to 'sell' itself on what agriculture has to offer. We must help in the search for new facts and processes, and in the demonstration of feasibility." In other words, as advance agents of agriculture, we must help make it thoroughly satisfactory to industry as a source of raw materials.

Finally, Dr. Knight reveals a belief that the new combination of chemistry and engineering in the bureau which he heads, and its enlarged personnel and research program, will facilitate increased cooperation with chemists and engineers in industry. It appears that he believes thoroughly in agricultural engineering and stands ready to help agricultural engineers, both in public service and in private industry, render their maximum possible service to agriculture.

Penetrating Public Consciousness

PRESIDENT William McClellan of American Engineering Council has neatly summarized its activities under two general headings, namely, the "embassy function" and the "penetration function." Of these, the "embassy function" is familiar terminology which has survived several years of use and become pretty well understood among engineers. However, we blinked twice and opened our eyes a notch at the words "penetration function."

If we interpret his intent correctly, President McClellan has expressed in these words a concept of an aggressive program to penetrate the public, and engineering, consciousness with facts and engineering judgment on public questions involving "the potentialities and responsibilities of the engineering profession." He has stated in two words the program of American Engineering Council for relating engineering technology more closely to the social and economic objectives of its application.

The public consciousness to be penetrated is thickly encrusted with apathy toward the respective merits of various means of general social and economic progress. It bristles with antagonism due to the evils incorrectly ascribed to engineering progress. It is partly preoccupied with the siren song of various "isms" which claim to hold the solution to world problems. And it includes a worshipful but misguided and fickle element of transient support which believes that engineers can and should accomplish the impossible.

These attitudes toward engineering are not conducive to the mutual understanding desirable between engineers and their clients. And the public is the engineer's client in public works, and parts of the public are his clients in private industry. Can engineers give satisfaction to clients who expect either too little or too much in the way of results? Can they enjoy professional satisfaction in working for such clients? Can they work at all for potential clients who are opposed to employing their services?

We do not believe that President McClellan would have professional engineers attempt to become also professional economists and sociologists. We do believe he would have them, individually and through their professional organizations, help their clients and potential clients to a better understanding of what engineers and engineering works can and cannot do, in terms of social and economic results.

A "penetration function", thus interpreted, implies first of all that engineers should penetrate with intelligent inter-

est the social and economic objectives and probable results of opportunities, proposals, and programs for either specific applications of engineering technology or limitations on its application. Secondly, it implies that engineers will or should help available engineering knowledge and judgment on these matters to penetrate to the public for its guidance in determination of desirable policy and action. And, finally, it implies the desirability of member organizations in American Engineering Council taking definite steps to contribute to the force and direction of the penetration. American Engineering Council has done excellent work in spreading understanding of the engineering profession, but as a representative federation it can scarcely spread enlightenment beyond that currently achieved and agreed upon by the majority of its member bodies.

Research and Extension Effectiveness

DURING the recent A.S.A.E. annual meeting, the scheduled joint session of research and extension groups seemed to run into a debate, with each side talking on a different proposition.

Extension men, in close touch with farmers and immediate, pressing farm problems, feel a great need for predigested solutions, specific recommendations, and workable applications ready made for extension teaching and quick results in farm practice. Pushed by heavy field schedules and some overtime work in planning their activities and preparing reports, extension men want someone to whom they can turn over engineering design and development problems and get results to take back to farmers. They want a source of practical, teachable subject matter and a source of answers to the posers with which farmers continually confront them. Their requests for help are legitimate.

Research men, being less in touch with farmers, and perhaps looking more objectively at agriculture, see almost infinite gaps in man's knowledge of natural laws, principles, and relationships governing agricultural production and satisfactory farm living. They see in the whole history of their technology a gradual unfolding of basic truth, followed by applications which have immeasurably benefitted mankind. Their urge to have a part in the unfolding is legitimate. One important discovery might easily prove more valuable to farmers than a lifetime of adding engineering refinement to empirical practices.

Meanwhile research reports pile up in libraries, often little used and half forgotten, to the mutual dissatisfaction of research and extension men. Some extension men apparently feel that research men should apply their efforts to more immediately practical problems; and some research men apparently feel that extension men are responsible for failures of research results to find their way into farm practice.

Who would say that the answer is either to seek less new knowledge or to be less concerned about spreading and applying it?

Possibly the question of providing a well-rounded engineering service to agriculture, by either a public service or commercial institution, involves more than reconciling the divergent views of research and extension men. If more development engineers or research interpreters are need to complete the serivce and increase the effectiveness of research and extension work, they might be worked in somewhere in the combined setup of the U.S. Department of Agriculture, the agricultural engineering departments of the land-grant colleges and experiment stations, and the interested industries.

Five Points on Progress

IN ATTEMPTING to summarize, recently, the nature of professional interest or the factors of professional progress in agricultural engineering, we identified five separate factors. These may be of some value to young agricultural engineers as a help toward achieving a balanced interest in and viewpoint on their branch of the engineering profession. These five points are as follows:

1 Understanding of agriculture and agricultural problems, as a guide to objectives and means of applying technology in the service of agriculture.

2 Engineering technology, as a group of tools with which to work effectively.

3 Recognition, not as a matter of feeding professional vanity, but as a means of gaining opportunities and support from powers outside of our group, to go ahead and apply our technology.

4 Standards of intellectual honesty and professional conduct, as a basis for developing, justifying, and maintaining public confidence and our own professional self-respect.

5 Development of new personnel, as a means of improving and perpetuating our professional group.

The first four of these points are immediate concerns of the individual, directly influencing his individual professional progress as well as that of the whole group. The fifth is particularly a concern of the group, of the teachers of degree courses in agricultural engineering, and of agricultural engineers who supervise the work of more recent graduates.

Individual proficiency is largely determined by the first two of these factors. They are dynamic, progressive subjects, of which even the most advanced agricultural engineers are necessarily continuous students. They are the factors on which the programs of A.S.A.E. meetings, committee activities, and publications have been concentrated. They are prerequisite to recognition, public confidence, and professional self-respect. Still, the other factors are important and need to be watched individually and collectively for points of possible weakness and opportunity for improvement.

The Industry Seminar

OBJECTIVES of the A.S.A.E. Industry Seminar mentioned in the news pages of this issue may be summarized in the words information, understanding, perspective, cooperation, and prospective employment.

In these days of complicated economic relationships, inadequate information on how the other half of the people live, and resulting misunderstanding and distrust, it is refreshing to see in our own field a strong countermove to alleviate the situation.

Last September the seminar proved successful as an experiment. The college men found the industry earnestly working to render a sound economic service, and the industry found itself being examined by no goldfish-eating crowd of rah-rah boys. Information and impressions gained in the course of the seminar spread widely through the industry and the colleges. We heard favorable reverberations as late as the A.S.A.E. annual meeting in June this year. The seminar continues this year as a proven effective method of accomplishing its stated objectives in its limited but important field of group relationships.

The Engineer and the Chemist in Agriculture

By Henry G. Knight

DURING THE more than 75 years since its establishment the U. S. Department of Agriculture has become large and very complex. Its offices and laboratories are filled with men trained in various specialties. Partly as a result of these factors of size and complexity the feeling has been growing that the Department should be organized along functional lines. Experience and reason seem to point to this method of approach to our problems as more convenient and efficient.

There are now in the various other bureaus of the Department of Agriculture more men trained in chemistry than there are in the present Bureau of Chemistry and Soils, or than there will be in the new Bureau of Agricultural Chemistry and Engineering which will take form July 1. Similarly, there are more engineers in the other bureaus than there are in the Bureau of Agricultural Engineering. They are to be found in the Soil Conservation Service, the Forest Service, the present Bureau of Chemistry and Soils, and in a number of other bureaus.

A few examples will serve to illustrate the functional organization of the Department. The Bureau of Plant Industry devotes its energies to the problems incident to the growing and improvement of plants and to accumulating knowledge related thereto. Hence, there are bracketed together plant physiologists, ecologists, biochemists, mycologists, engineers, soil scientists, and so on, all under one leadership which directs the sciences pertaining to plant problems.

The Soil Conservation Service employs economists, engineers, chemists, botanists, soil specialists, and other scientists whose knowledge may have a bearing on its problems.

The work of the Bureau of Animal Industry is carried on by animal husbandmen, pathologists, geneticists, zoologists, biochemists, and chemists. One of the assistant chiefs is a chemist.

FUNCTIONAL SETUP FOR PROBLEMS IN PRODUCT UTILIZATION

The Bureau of Agricultural Chemistry and Engineering will devote its energies primarily to the problems of efficient utilization of the products of the soil and our fertilizer resources. It will have on its staff chemists, physicists, engineers, architects, engineering chemists and biochemists, and other scientists whose knowledge may be of value in working out problems in this rather broad field. This bureau is also charged with carrying on fundamental research in the two fields of chemistry and engineering, as they may apply to problems of agriculture. In other words, there is a functional type of organization, backed up by a reservoir of fundamental knowledge and research which the Bureau will attempt to husband and increase at the same time it pushes ahead with strictly functional activities.

Agricultural chemistry was once a soils, food, feed, and fertilizer science. Now the agricultural chemist recognizes as his field, in part at least, the processing industries and the various conditionings and technological changes that are necessary in carrying farm products on to the consumer in various modified forms. The agricultural chemist also recognizes new uses as his field. He looks upon himself as the farmers' helper in dealing with agriculture in many phases.

Possibly the agricultural engineer has been operating in too narrow a field. I hesitate to say this as I know that the men before me in this meeting represent a great variety of activities. Nevertheless, when I consider the fact that, so far, products of the farm have come into industrial utilization, outside of food and clothing, only to a very limited extent, I cannot help but feel that there are great opportunities for agricultural engineers to expand their work. Intimate acquaintance with farm commodities and their production should give them a very special advantage. I feel confident that in years to come this American Society of Agricultural Engineers will have more and more members who had, as you might say, come off the farm as agents in developing better outlets for the farmers' products. Not only do I think that development likely, but I am sure that developments in the industrial field will emphasize the need for specific things to be done in the production field, in order that special demands on the part of manufacturers can be met, and met economically.

FUNDAMENTAL RESEARCH CONTINUED

We are doing and will be doing fundamental research—if you please, pure science research—in these two fields of agricultural engineering and agricultural chemistry, and I hope this work will be recognized as the last word upon many questions that may arise in the field that we cover.

It should not be forgotten that the new bureau has back of it more than 75 years of enviable records in research. The first chemist in the Department of Agriculture was also the first scientist of the Department of Agriculture.

Engineering history in the government goes back much farther, but it is difficult to segregate the engineering work of particular interest to agriculture from that carried on for other purposes. The definite origin of the work that led up to the formation of the Bureau of Agricultural Engineering can be traced back more than forty years to the initiation of irrigation investigations in the Office of Experiment Stations in 1898. The first president of our country was an engineer, or we might say an engineer-farmer, possibly the first agricultural engineer, since his engineering work was largely done as a surveyor of public lands. He also surveyed the route for a canal which was long used to bring farm products and coal to the city of Washington. Agricultural engineers have a right to assume that their activities reach back at least to the founding of the nation.

Engineers and chemists, as a team, are what we might call a "natural," if we mean that they naturally fitted their work together in the early days because it was obvious that their first, simple devices functioned effectively that way. Engineering is commonly thought of as having had its beginning in military engineering. The chemists, or their predecessors, the alchemists, did some of their first work for military purposes. They invented that fearsome liquid combustible, Greek fire, which had so much to do with the continued existence of the Byzantine Empire, but which had been used hundreds of years before. They developed stink pots, perhaps the earliest form of the gas bomb. Some of these agents of destruction and discouragement were thrown into the enemy ranks, onto ships, or into fortifications by

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An address before the 32nd annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June 20, 1939. Dr. Knight is chief of the new Bureau of Agricultural Chemistry and Engineering in the U. S. Department of Agriculture.

means of the engineers' catapults. The progenitors of the chemists produced gunpowder and the engineers made guns. The engineers had previously made crossbows, and we might give the sprouting chemists the rather dubious credit of having provided poison for arrows. Both groups have horrified humanity much more successfully in recent times.

In our particular fields in agriculture, developed intensively only in very recent times, we have the great satisfaction of knowing that what we have done has tended amazingly to the improvement of the standard of living, to increasing our comfort and convenience, and has added to our leisure.

Developments in modern agriculture provide scores of examples of how engineers and chemists have together developed new methods, materials, and equipment.

While engineers have been improving internal-combustion tractors for various farm uses, chemists have been perfecting fuels for them and recently have been trying to make it feasible for farmers to have fuel for this purpose made from their crops.

TEAMWORK IN CHEMISTRY AND ENGINEERING

During the time that engineers have been improving plows and other soil-moving equipment, chemists have been working toward a better understanding of the chemical nature of various soils that react differently to tillage. At the same time better and cheaper fertilizers have been created, more has been learned about their placement for various crops, and machines have been designed that will put the plant food just where the particular crop can make best use of it. Chemists, engineers, and crop specialists have made a big contribution to better farming in this work.

This same group, with the help of the entomologists, has made great headway in the development and use of insecticides and fungicides and machines for applying them in the forms of liquid, dust, or gas.

In the storage of grain, a problem that has demanded increasing attention these last few years, engineers and chemists are taking a hand, for we have to know not only about the kinds of structures and ventilation, but also about the moisture content of the grain, any changes that occur in it, and means of controlling pests.

Ever since the invention of the cotton gin, probably the first big mechanical improvement in the history of American agriculture, there have been engineering improvements in ginning. The perfection of this process, which caused a great increase in cotton growing, brought along with it our first big farm waste product, cottonseed. This waste was a stench in the nostrils, both really and figuratively, until chemists and engineers together made the seed the basis for one of our major farm product industries. Ginning improvement has gone on with vigor in recent years and so has the study of cottonseed and cottonseed oil and of cotton fiber and cotton fabrics.

Weed control was once very largely a matter of sharpness of hoe and dullness of muscles, but now it is coming to be a matter of mechanical ingenuity in cultivators, seed cleaners, and chemical agents, to say nothing of farming practices.

The harvesting and storing of hay have been largely mechanical, but our chemists have been lending a hand here, too. There must be analyses to determine what changes occur in forage plants at different stages of growth and as a result of different handlings at harvest. Also it is desirable to know more about spontaneous combustion and how it may be prevented. Much has been learned about that.

The storing of corn as silage brought the development of special machinery and structures, but it also brought new work for chemists in the study of the silage material, of things that might be added to the corn, of the biochemistry of silo fermentation, and the effect of these products upon the quantity and quality of the milk, and of the effects of silage acids on the materials of the silo. Now, with increasing interest in the making of silage from grass and other crops, both engineers and chemists have more work to do since these other crops produce higher pressures on silo walls and added materials are needed to make the most nutritious and acceptable feed.

Even in the construction of buildings, the teamwork of engineers and chemists has gone on for a long time. Plainly the engineers and architects provide the fundamental work for structures, but cements, plastics, paints, preservatives, and durable roof coverings are essentials, and at present chemists are trying to use more and more of farm products in supplying these products.

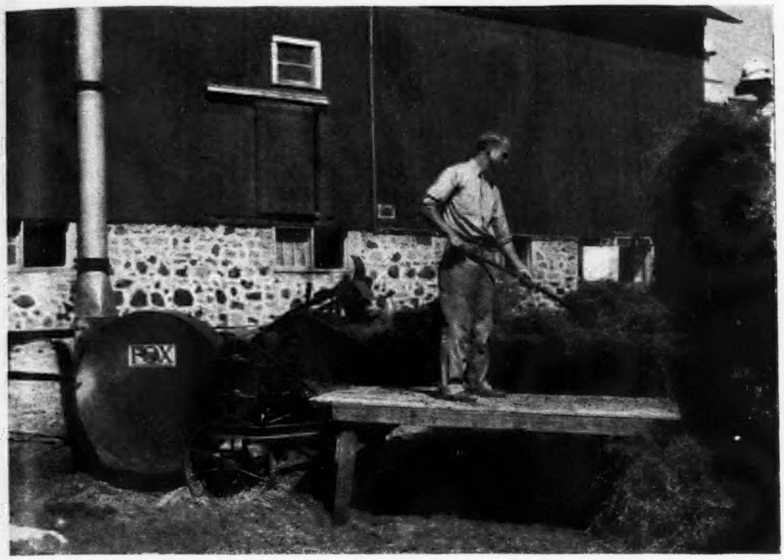
One of the more unusual problems of agriculture on which chemists and engineers have worked is that of dust explosions. Starting with studies of explosions in threshing machines and grain elevators, investigations have led to means of preventing and minimizing such disasters in plants handling many agricultural products and, incidentally, some other products. One of the engineers associated in the dust explosion work, although employed as a chemical engineer, is a member of this Society and, presumably, an agricultural engineer. I think the A.S.A.E. is right in classifying such work as agricultural engineering. In carrying on this research the investigators get off the farm in many cases, but they work with farm products. The threshing machine was on the farm and many grain elevators are very near to it, but the largest are far away in the big cities. Flour mills, starch plants, and soybean mills, where these studies have resulted in reducing the explosion hazard, are decidedly off the farm, but there is a close relationship with the farm.

CHEMISTS AND ENGINEERS AS ADVANCE AGENTS OF AGRICULTURE

It is apparent that agriculture may gain much if engineers and chemists devote themselves to agricultural problems somewhere off the farm. Men in our agricultural-industrial utilization work may be looked upon as advance agents for agriculture who go ahead to create a demand.

Some of this advance-agent work has been going on in the Department of Agriculture and elsewhere for many years, but until recently there was no vigorous forward movement in this direction. Years ago the Department began industrial utilization work. Back in 1862, the year the Department was established, its first scientific report had to do with the development of a wine industry. Early in the present century studies were made on the manufacture of paper from farm wastes and a Department bulletin on the subject was printed on paper made from five of these straw, stalk, and hull wastes. A little later other work on farm waste utilization brought out a cheap method for furfural production from corncobs and oathulls, a method now the basis of a commercial industry. The laboratory that did this work grew into the agricultural by-products laboratory which has been operated for a number of years in cooperation with Iowa State College. In 1936 studies in the industrial utilization of the rapidly expanding soybean crop were begun in a cooperative laboratory at Urbana, Ill., with twelve states cooperating with the Department. In addition, industrial utilization work on surplus and cull fruit has been carried on at the laboratories in California, Florida, New York, Oregon, Texas, and Washington.

The research at these laboratories, as well as industrial utilization work of some other kinds in the Department,



THE CHEMISTRY OF HAY STORAGE TO PRESERVE A MAXIMUM OF NUTRITIVE VALUE AND MINIMIZE THE DANGER OF SPONTANEOUS COMBUSTION, AND THE ENGINEERING OF HANDLING METHODS, EQUIPMENT, AND STORAGE STRUCTURES ARE ASSOCIATED PROBLEMS IN EFFECTIVE FARM PRODUCT UTILIZATION

such as that on cotton, wood, and naval stores, has led by natural stages to the present expansion represented by the four regional laboratories now in their beginning. However, the force that brought this present strong support for expanding our efforts to develop greater use of farm commodities in industry was a widespread realization by our agricultural leaders and the public that the country is faced with surpluses of the common and usually marketable farm products, as well as with mountains of so-called wastes, such as cull fruits, straw, stalks, and hulls.

Up to now agricultural research men, and I may as well emphasize here particularly the agricultural engineers and chemists, have put most of their energies and ingenuity into production problems of the farm and the problems of processing raw materials used for food and clothing. Now it is becoming plain that we have reached a diversion point where, as I said before, some of our investigators are going, as you might say, off the farm. Economic conditions have brought about this change; that is, surpluses beyond the usual needs for farm commodities have presented themselves on that big market where all nature's products, from mines and oil wells as well as the soil, pass under the appraising eyes of all the industries of the world.

Since agriculture is looking to industry for new outlets, research on industrial utilization of farm commodities must make it as easy as possible for industry to "sell" itself on what agriculture has to offer. We must help in the search for new facts and processes and in the demonstration of feasibility.

Because engineering is important in all industrial utilization work, both in production and in processing of the raw material, you will be interested in knowing something of the plans for research at the four regional industrial farm products laboratories now being organized by the Department of Agriculture. A committee appointed by Secretary Wallace decided that for the northern regional laboratory studies should be directed at first toward finding new and wider industrial uses for corn, wheat, and agricultural waste products; for the southern laboratory, cotton, sweet potatoes, and peanuts; for the eastern laboratory, tobacco, apples, Irish potatoes, milk products, and vegetables: and for the western laboratory, fruits, vegetables, Irish potatoes, wheat, and alfalfa.

Not only will work be done on these crops specifically in attempts to increase their uses in industry and to widen present uses, but there will be research on important constituents such as starch, cellulose, fats, and oils common to several crops.

I am going to speak just a little about some of the things we have planned to do. Let me take corn as one example. The early work planned, with due consideration of research going on elsewhere, includes fermentation products, starch, glucose, and motor fuels. In spite of all the work that has been done on these products of our largest crop, I think most of you will agree that we need to know a great deal more about them. Members of this group have probably worked on some of these problems, most certainly on that one of motor fuel. From what has already been done on all sorts of motor fuels, we have good reason to believe that the possibilities have not yet all gone through the exhaust pipe. We needn't limit our studies to alcohol, for it is entirely possible that we may be able to do something with a glucose product, with a gaseous fuel from vegetable sources, or with dry starch. Starch is one of our cheapest organic materials of high purity, and yet recently a well-known specialist in the corn products industry said that most of their starch processes are still based on empirical knowledge. There is great likelihood that, when research brings out more facts, the result will be more uses and wider use.

A great deal of work has been done on cotton, and industry already makes use of all the lint and much of the seed. But cotton fiber goes almost entirely into fabrics. In the Department of Agriculture we have done valuable work that has contributed to the development of the use of cottonseed oil and to wider uses for lint, and engineers and other specialists at the federal cotton ginning laboratories have cleared the way for improved lint and lower ginning costs by developing better equipment and methods that are now in wide use. We are going to investigate the products of the cotton field from various angles, in the hope of finding more uses and widening present ones.

Engineers have had a hand in the more or less successful war on insects and other pests of crops. In the research to uncover new and wider uses for tobacco, the regional laboratories at present pin their greatest hope on the possibility of more use of nicotine for combating chewing insects. Considering the improvement tendencies in recent years, I should say that mechanical aids may be a factor in helping with this work, as they have been during the

whole history of modern insect control on a commercial scale, from grasshoppers to codling moths.

The possibilities of greater and more profitable use of farm wastes of various kinds have been under investigation and now, along with work on the regular commercial parts of those crops that are often produced in surplus, we plan to do more work on these so-called wastes—straw, stalks, hulls, and such things. A good deal of progress has been made in utilizing sugar cane bagasse and oat hulls, and quite a lot of straw is used in making strawboard. But the quantities of agricultural wastes are so enormous that present industrial uses are a very small drop in a bucket almost as big as all outdoors. So there is much for both engineers and chemists to speculate upon and to try out. Most of the industrial uses now are of wastes that accumulate in large quantities in one place. To make more profitable use of the scattered materials that would be profitable if they could be cheaply collected, some preliminary problems must be solved. It looks as if we are obliged to develop some local processing, mechanical or chemical or both, to reduce bulk and to throw out the less useful part. We already know how to make useful products from the principal farm crop wastes, but the economic obstacles are in most cases too great to surmount with our present knowledge.

Right now, in the Department of Agriculture, we are at grips with certain specific economic difficulties that have arisen to plague us after we had learned how to produce from farm crops certain finished products in demand in industry. Sweet-potato starch is a good example. The sweet potato is in the front rank among plants as a starch yielder and the chemists finally developed ways of making from it a white starch suitable for sizing cloth and paper, for laundry use, and for special adhesives. But it is necessary that this starch be cheap. Such an industry can not be safely developed entirely on the use of culls, so there is the agricultural problem of growing a big tonnage and harvesting it economically. Lately agricultural engineers of the Department have been investigating methods of harvesting, designing and trying out new machines to get vines out of the way, as well as to get the potatoes out of the ground and into the wagons. It seems desirable also to develop cheap methods of pulping and dehydrating a part of the crop so it can be stored to supply raw material for year-round operation. Before we get a well-developed starch industry based on the sweet potato, the engineers and the crop specialists will have put in a great deal of work. I am convinced that with the teamwork we have, ultimately both the farmer and the user of the starch will be satisfied. Problems similar to this one are likely to be common as we extend our efforts to make the farm a big source of industrial materials.

Since one of the prime objects of the work I have been discussing is to use surpluses effectively and profitably, it would seem hardly reasonable in me to pile up a surplus of examples to illustrate my points. I have mentioned corn, cotton, tobacco, sweet potatoes, and waste products of various crops. They can serve the purpose for the present. The survey committee appointed by Secretary Wallace provided a basis for the location of the four regional research laboratories, pointed out the scope of the work, provided the basis for coordinating the research with that of other institutions, and suggested a program on which to begin. The committee's report was submitted to the Congress early in April and will be printed soon as a Senate document. Just how soon it will be off the press I cannot say. It will be a large, three-part report, full of basic information on 74 farm commodities, statements on research now going on, and preliminary plans. But it contains no predictions.

Neither are we, who have been given the job of realizing these laboratories, going to give our imaginations the pleasure of prediction. We know that here, as well as in all other research work, the reasonable view is that it is a long-time search that is not likely to run down any valuable game short of several years. Still it is reasonable to feel optimistic, for we shall have good equipment, a far larger personnel than was ever available before for this type of work, and laboratories so located that it will be possible to have excellent cooperation from chemists and engineers carrying on research and production work in industry.

I want to extend to the American Society of Agricultural Engineers and to the individual members an invitation to make suggestions to the Bureau of Agricultural Chemistry and Engineering, to visit our laboratories at any time, and to call upon us for assistance whenever you think we might be useful to you. This society is a young organization in the field of engineering, and a vigorous one, if I may judge from the high percentage of the membership that attends your meetings and from the appearance and content of your monthly publication, and I hope that you and the Bureau of Agricultural Chemistry and Engineering will have years of pleasant and profitable relations while we together do our best to help solve some of the most difficult problems of agriculture.

LOW COST OF COLLECTION, STORAGE, AND HANDLING IS ONE OF THE PRIME CONSIDERATIONS OF FARM WASTE UTILIZATION. IT IS SUBJECT TO ENGINEERING IN THE MECHANICS AND ECONOMICS OF POWER AND LABOR APPLICATION, INVESTMENT COST, EQUIPMENT USE FACTOR, AND VALUE OF THE WASTE FOR RETURN TO THE SOIL COMPARED TO ITS CASH VALUE FOR INDUSTRIAL USE

A Farmer Looks at Farm Structures

By William A. Benitt

THIS SPRING on our 200-acre farm we used our 10-foot grain drill exactly three days to put in our entire grain crop. Had it not been for two of our neighbors who also used it, the drill would have been in use one per cent of the year and been idle 99 per cent of the time. Fortunately, mobility of farm machinery makes it possible for several farmers to cooperate in using a single piece of equipment, thus saving capital outlay, interest, shelter, taxes, insurance, etc.

Farm structures, on the other hand, do not possess any, or relatively little, mobility, and a building on one farm does not lend itself readily to use by another farmer. Farm homes and buildings on the farm must be supported by the farm enterprise. Buildings that are used to only part of their capacity, or used for only part of the year, must bear the total annual charges the same as though they had been so used.

Farm structures stand in a somewhat different relationship to the owner and operator than do manufacturing or business structures. The latter are usually separate and distinct from the home. Not so with the farm enterprise. The farm home and the farm buildings are a unit. The farm factory comes up to the kitchen door. Yes, we can even say it spills over into the kitchen, and at times envelops the entire home, merging the home and factory into one, and both become just a factory.

The prime essential of the factory is profit—income commensurate with the risk, labor, investment, etc. While it may appeal to a man's vanity to have a beautiful farm factory, that in itself may not spell satisfactory returns. And beauty from a strict business point of view can justify a capital expenditure only when it brings added returns. These added returns may be in the form of more efficient labor performance, or in greater pride on the part of the workers, leading to better quality of work, or in advertising the business. The primary motive is profit.

The farm home stands or should stand on a different footing. It should be a place of beauty. The profit motive is secondary while the aesthetic should be primary.

SOCIAL ASPECTS OF THE FARM HOME

Farm buildings, therefore, have more than a mere economic aspect. They have a social aspect as well. For that factory is the home of a family, and that family is playing a very important role in our democratic institutions. The farmer has properly been called the stabilizer and perpetuator of democracy. He is both a laborer and a capitalist, and he is not likely to veer very far, nor for a very long period, to either the right or left. By nature conservative he is slow to follow the rabble rouser. He is one man alone in his farm operations. He has more individuality per cubic foot of protoplasm than any other piece of humanity, not even excepting engineers! Go to town meetings and country school meetings and you will see democracy in operation more nearly to the ideal than in any other governmental unit. In making this appraisal you must, however, look beyond the clothes worn by the participants.

Around 150 years ago about 95 per cent of the population of the United States lived on farms. Today only between 20 and 25 per cent live on the land. The farmers as a group now are a small minority instead of the predominant group of a century and a half ago. Farm homes have contributed heavily to the population of the cities. The farm families are the large ones. Three-fifths of the families who have seven or more members live on farms. Small families are urban, large families are rural, and the city recruits its population yearly from the youthful rural excess. In large cities in 1930 the children under 5 years of age lacked about 22 per cent of maintaining the population. From 1920 to 1930 there was a net immigration from the farms to the cities of 6,300,000 persons. And it is the young people that leave and the old that stay on the farm. It is apparent from these figures that the cities are receiving each year from the farms the young people just ready to begin adult work—whose going impoverishes the farms they leave and whose arrival enriches the cities and maintains their population. It has cost the farmers great human effort and money to raise and educate these youths to working age. The cities are the beneficiaries. Since there is this large annual influx of farmers' sons and daughters to the cities, it behooves the urban dwellers to give due thought to the background from which this youth comes.

VALUES OF COMFORTS AND CONVENIENCES

Life on the farm has been largely without modern comforts and conveniences. Farm life has been lonely. Farms with running water, electricity, modern sewage disposal, and central heating are still very much in the minority. The farm home for the vast majority of country people is still not so very much unlike the one used in grandfather's day. Why should our young people remain in that kind of an environment in contrast to the bright lure of the city? I wonder just how much humiliation our farm boys and girls suffer when their city friends visit the farm, and find their farm homes considerably below the standards of city homes. Or to avoid humiliation, how often are friends just not invited to the home farm? Or perhaps our boys and girls seek to escape showing the farm home by going places that you and I would rather not have them go.

The farm home, therefore, concerns more than the people living within its walls. The question is: What is that home contributing to the well-being of society? Is it a place of peace, tranquility, serenity? Or is it a place of drudgery, a place of labor with no other end in view?

A farm home is not a part of the farm business. Accountants so regard it, and even the income tax collector treats it as an entity separate and apart from the farm business. This is on the theory that investment in the farm home is a personal item with no relation to the farm business. Yet who can say that in a raging blizzard the comfort and convenience of a modern home are not assets to the farm business? Hot water on tap enables us quickly to remove the chill from the water for the poultry. Tepid water is needed for a sick animal. Eight gallons of warm water are needed when the tractor is started. A drinking cup is frozen and hot water is again in demand. Can we

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An address before the annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June 21, 1939. Mr. Benitt is a farm owner and operator at Hastings, Minn.

say that running hot water in the farm home is personal, disconnected from the farm business?

The contribution of running hot and cold water in the farm home does not lend itself to statistical measurement. A farmer who has worked in the dusty fields all day comes home dirty, grimy, and sweaty. A warm shower bath greets him. His collection of dirt goes into the septic tank instead of onto the sheets. He goes to bed refreshed and has a good restful sleep. How much has this added to his efficiency the next day? How much has it added to the serenity of the home? What is its effect on the other members of that home? How much work has it saved the homemaker? How much of her time has been released for the productive end of the farm business? His clothing also can conveniently be made comfortable for the following morning. If anybody's stockings need "luxing" at the end of every day, I wonder if it is not the farmer's?

THE MODERN FARM A PLACE FOR RETIREMENT

Considering the economy of time and effort that running water brings to the farm home—to say nothing of increased personal efficiency, decency, pride, and nicety of living—one wonders why so few farmers have made any endeavor to modernize their homes. Have our homemakers meekly submitted to medieval home inconveniences while every dollar of savings has gone toward productive improvements? Or have home conveniences been regarded as luxuries? Or do farmers regard their farms as factories, to earn for them as high a rate of return as possible, so that they can then move to town to get some pleasure out of life? While this might have been the case in the past, the automobile, the modern movie, the radio, and the telephone have brought everything that the city dweller alone used to enjoy within easy reach of rural people. The coming of central station electricity brings within the realm of possibilities, at very moderate costs, every modern convenience of which the most sumptuous home in the city can boast.

Thus the farm home should no longer be regarded as a purgatory from which release is to be sought as soon as farm earnings warrant, but rather the farm home should be a place of culture and comfort, enjoyment and serenity. For, if America is to build and maintain both a city culture and civilization and a rural culture and civilization, the focal point for the latter must be the farm home. And that home must possess the necessary physical comforts and conveniences and the spiritual environment to make those requisites a reality.

A question of paramount importance to the farmer is the present disparity of income. Let me say in the beginning that prices of commodities sold by Minnesota farmers at present, in the aggregate, are not low. But prices of things the farmer buys—particularly building materials and labor—have advanced markedly. Today the Minnesota farmer gets roughly the same amount of money for his load of produce that he did 25 years ago. But it buys, in the aggregate, only about 70 per cent as much. A bushel of wheat sells today for around 60 cents. Twenty-five years ago a loaf of bread made out of 75-cent wheat cost 5 cents. Today that same loaf made out of only 60-cent wheat costs 10 cents—just twice as much. According to the 1938 Statistical Abstract of the United States, the price of all building materials has advanced about 80 per cent in the last 25 years; construction costs have advanced around 165 per cent during the same period; the price of lumber during this period has almost doubled, while the union scales of hourly wage rates have more than doubled. Now I am not opposed to high wages for skilled craftsmen nor for people engaged in industry. But it seems to me that it should become apparent to the leaders of labor that an excessively high hourly rate does not mean a large annual wage. A rate of $1.25 an hour is of little benefit to the man who does not work. It seems that businessmen also must realize that extreme price rigidity and inflexibility can result only in violent fluctuations of volume of production. This is especially true of their dealings with farmers. Farm prices are relatively flexible. A drop in the general level of farm prices can result in only one thing—lowered farm purchases. As applied to farm structures it means lowered sales for manufacturers, processors, transporters, and handlers of building materials, and lower incomes for carpenters, bricklayers, painters, electricians, etc.

We had a great war 23 years ago and practically all prices were boosted during that period. But there are many who apparently do not seem to realize that the war is over, for their prices are still sticking at war levels or only a little way down. Keep those prices frozen at that figure, frozen to the ceiling, so to say, and you are simply choosing to keep men from working. We are just as wealthy as we were 10 years ago, or 25 years ago. We have the same skilled men, the same machines—probably better ones—the same factories, and some probably better, as much land and more money than we had in either 1929 or 1914. But, notwithstanding our ingenuity and resource, the machine is kept from functioning. We are living the paradox of scarcity in the midst of plenty.

It might surprise the building trades and the so-called skilled labor crafts if they took a leaf from the book of agriculture in regard to price structure and volume. There is an old economic law, which now seems to be mostly forgotten, that under a system of free competition or free enterprise the price of a commodity will tend to be established at the point which will affect the largest number of sales. But you cannot consistently argue that a policy of *laissez faire* shall apply to agriculture but not to anybody else.

It should also be clear by this time that expenditure of huge sums on works projects, where all that matters is the rate of pay per hour irrespective of the amount of work accomplished, will not and cannot be the way in which building for productive purposes can be started and maintained.

ECONOMIC CONSIDERATIONS OF FARM CONSTRUCTION

With the increasing costs of construction, the question of the economic wisdom of building farm structures becomes more puzzling. Fortunately the loan provisions for constructing and remodeling farm buildings have been liberalized and the payments amortized over a relatively long period of years. Once a farmer is convinced that a new or remodelled building is in all likelihood going to be a self-liquidating project, pay all its fixed charges—taxes, insurance, upkeep, interest, depreciation, and obsolescence—he need not hesitate to build. I am still old-fashioned enough to believe that it is better to get the money first and spend it afterwards. The financial obstacle, however, has been largely removed, even for the farmer whose credit is not of a first-class bankable character.

Farmers, however, should give most careful consideration to new farm structures. It goes without saying that this involves careful and proper planning, suitable materials, and proper construction. They should also be conveniently located. Consideration should be given to the question of the annual charges that should be made against a building. Most farm structures are built to outlast the

FARMING IS NOT STATIC. CHANGES IN MARKET DEMAND, IN KNOWLEDGE OF SANITATION, IN OPERATING EQUIPMENT, IN ORGANIZATION FOR EFFECTIVE OPERATION, IN DEGREE OF DIVERSIFICATION, AND IN TYPE OF PRODUCTION INVOLVE CHANGES IN FARM BUILDING REQUIREMENTS. THIS SUGGESTS A NEED FOR MORE ADAPTABLE FARM BUILDINGS

useful life of the builder. What is to become of the buildings after his retirement, removal or death?

Let us take a $5,000 dairy barn. If we assume a 3 per cent depreciation charge, that would be a $150 annual charge. Suppose at the end of 10 years the owner dies or is compelled to retire or move. Can we assume that because we have depreciated the barn $1,500, it is still worth 5,000 minus 1500, or $3,500 for sale purposes? If so, well and good. If not, have we not underestimated the annual depreciation charge, and included too little for obsolescence?

If there is a child in the family who wishes to carry on the farm business along the same lines, the depreciation schedule can be maintained and values written off at the rate of 3 per cent for 33 years. If, however, there is no son or daughter, or they are unable or unwilling to carry on the farm business, then the question of sale or rental must be considered. In general, is there not a very grave question of the advisability of providing a first-class set of buildings if the farm is to be rented? If the farm is being sold, the question is, What is the sale value of the buildings? It is not uncommon these days to be able to buy a farm with buildings for less than what it would cost to put up the buildings alone. Except in periods of advancing prices the seller must usually discount the value of the buildings in order to make a sale. The difference between book value and actual sales value the farmer must charge to the cost of farm buildings. I am not saying that this is an argument against good buildings. I merely wish to point out that a farmer, building any kind of a farm structure, usually must at the end of his farming days be prepared to discount the value of his buildings. He may be willing to pay this discount because of the convenience that the buildings afforded him during his active farming life. They may have freed him from irritations and irksome situations. The pride in having good structures may be worth it all. But a person who contemplates the step of building a new farm structure should, in fairness to himself, count all the costs, not only depreciation and repairs but also obsolescence and possible sales discount as well.

One possible explanation of this situation may be the continual changes in agriculture. Farming is not static. Methods, machines, and practices of today are outmoded tomorrow. When we moved on to our present farm 9 years ago we found a 200-acre farm with a barn 36x40 ft equipped to house 17 horses and 3 cows. A 24x36-ft hay shed was about 200 ft away from the barn. When St. Paul and Minneapolis business houses made all their deliveries with horses, the production of horses, hay, and oats was a good business. But those cities no longer need our horses, much less our hay and oats. Consequently, the farms no longer need large horse barns nor isolated hay storage shelters. With our tractor and two horses such a barn was ill-adapted to our needs. In appraising such a structure the new operator must consider its value minus the cost of remodelling to suit his animals and equipment.

With the advent of sanitation in hog production the permanent hog house with its disease and worm-infested feed lots probably cannot be considered much of a farm asset. In our case a 24x32-ft hog house was remodelled into a cattle shed and the hogs turned into movable quarters.

The house that we moved into nine years ago consisted of ten good-sized rooms, and had housed four times as many people as there are in our family. With no running water, no sewage disposal, no electric current, walls uninsulated, remodelling was again the order of the day.

A question regarding present and future farm building construction is what effect mechanization and industrialization will have on the farm business of tomorrow. My father plowed his ground with a two-horse walking plow and walked behind his harrow. He and my mother planted their corn by hand, covered the seed with a hoe, and firmed the soil with their feet.

These laborious operations have been simplified by the use of the rubber-tired tractor and machinery. But in order to justify the investment in a tractor, a two or four-row corn planter, cultivators, corn pickers, and combines, the amount of land operated must be large enough so that production costs will be lowered. Fixed charges and operating costs must be lower than if less machinery and more labor were used. This, it seems, will have to be brought about in one of two ways: Either several farmers cooperatively will use one machine, or the farming units will become larger. We probably shall have some of both. In so far as farms are enlarged, it will probably mean the abandonment or removal of part or all of the farm buildings of the absorbed farms.

Further mechanization will doubtless bring with it further specialization. With modern tillage tools, with tractor power, and with planting, cultivating, and harvesting machinery, a farmer could step up his production of corn, say, from 50 to 200 or even to 300 acres without an additional cent of investment. Instead of producing a variety of crops and feeding it to a variety of animals housed in various kinds of buildings, one or two crops are produced, and the livestock enterprises simplified accordingly. Thus, the diversified farm has shelters for horses, for cows, for hogs and chickens; for forage crops, small grains and corn, machinery, vegetable cellars, etc.—a virtual miniature city to house the diversified farm industry. By contrast the mechanized farm would probably specialize in only one or two crops. There would be no attempt to make the farm as nearly as possible a self-sufficient unit. The eggs would be put pretty much in one basket. The need for many of the buildings necessary for the diversified farm is obviated. Instead, a specialized type of building entirely alien to the diversified farm is in demand. Should this specialization proceed, some of the structures on diversified farms now will either be abandoned, or, if they lend themselves to remodelling, will be devoted to another purpose.

A characteristic of some farm structures is the inflexibility of use. Take the modern dairy barn, for example, with concrete mangers and gutters, stanchions, partitions, drinking cups, salt boxes, etc. It does not lend itself to any other use. It can not be used for horses, or sheep, or hogs. Once such a barn is built, you are doomed to stay in the dairy business for a generation or two at least. You may choose not to have milk cows, but your overhead cost is there nevertheless. To remodel such a barn would be quite costly.

We need to recognize also the changing character of production. Within the memory of most of us is the time when butter and eggs were relatively high priced in winter and cheap in summer. While there is still a price disparity, the difference is much smaller and it is for a much shorter time. Am I too fantastic to suggest that some producers of dairy products might have a higher income if their herds were pointed for heavy production during the spring and summer and "roughed" through the winter? The cost of shelter and care could be materially reduced under such a system of herd management.

One may also be led to wonder if it is any kindness to imprison cattle in a barn in winter. Our beef breeding herd often lies beside a strawpile in zero weather while a well-bedded barn with the door wide open is unoccupied.

ELECTRICITY AS AN AID TO EFFECTIVE LIVING

A word should be said about the movement to bring central station electric power to rural communities. Electric wiring is an integral part of farm structures.

Probably there is no one thing that is adding quite so much to farm comfort and convenience in farm buildings as central station electricity. Here is one single agency that furnishes light, heat, and power. The wiring of farm buildings and yards—furnishing the highway for electricity—is a necessary part of modern farm structures. The cost of wiring is an essential item in the cost of the building.

The point has been raised, whether or not the use of electricity for light alone could be justified. Statistically this is also incapable of measurement. For several months in the fall, work in the fields goes on until sundown. Chores are done in darkness or by artificial light. If by the snap of a switch the barn can be flooded with light when the team is brought in at night, and chores can be done with the same ease and facility as by daylight, it makes for better care of the animals and consequently better production. Fire hazards are minimized. The work can be done with less effort. For instead of using one hand to carry the lantern, both hands are free to tackle the job.

The grass on the other side of the fence is always greener than it is in the pasture, yard, or paddock. And you do not fully appreciate adequate yard lights until the cattle, on some dark night, start to prove that theory. The final checkup before going to bed is also a much pleasanter journey if it can be done in lighted buildings and lighted yards. The greater ease with which chores are done in well-lighted buildings and yards prevents accidents and mishaps. The energy of the workers is conserved and makes possible some degree of home life and recreation instead of dropping into bed as soon as the days work is over.

Poultry lighting is so well known that nothing more need be said about it. A $7\frac{1}{2}$-watt lamp in the brooder houses, if other conditions are right, helps to prevent the chicks from piling at night. If something unusual frightens the chicks, like an automobile headlight, they pile into a corner. If the place is lighted, they unscramble without fatalities.

Probably the well-wired and well-lighted home offers the greatest dividends, particularly in the realm of the intangibles. Instantaneous illumination makes it possible to make the entries in record and account books. Or rather, I should say, you have no excuse for not making them.

The hot water heater and electric refrigerator, both without fumes and fire, make refinement and luxury of living a reality. While neither could probably be considered a part of a farm building or even farm equipment, certainly the electricity and the wiring of the farm home are a necessary part of any home that can be called modern.

SATISFACTION IN LIVING

Possibly no one simple piece of home equipment will do so much for rural culture and rural adult education as the bed lamp. Somebody else can feed your horses and cattle. Somebody can plow your fields and harvest your crops. The eggs can be gathered and the milk drawn from the cows without your putting your foot outside of your home. But nobody in your stead can gather wisdom from the sages of the past. When the day's work is done, you lie in your bed, the bed lamp is turned on. Until sleep overtakes you, you read, probably about developments in agriculture; perhaps you travel in far-away lands; you may catch a glimpse of stars and planets and get a little vision of the mighty elements and forces that have made this world. These things no one can do for you. Each must learn and experience for himself. No one in my stead can appreciate good music or fine poetry or wholesome philosophy. There is no proxy for the soul. Each for himself must find or experience the thread of the divine purpose which dominates the universe. And in that little interlude between labor and sleep, the electric lamp, at the head of the bed in our home, shall be the guiding light to fields anew and the wonders of the universe.

Yes, one appreciates the wisdom of Dean Coffey's words in one of his radio broadcasts. He spoke about coveting a home—a home that is what it should be—coveting it above food and clothing. And he quoted from an inscription on a public building in Sweden: "Eat below your earnings, dress according to them, and establish your home above them."

A Comparison of Two Types of Concrete Slab Structures for Soil Erosion Control

By Horace J. Harper

MECHANICAL structures provide effective control of runoff water, but the high cost of installation restricts their use, in most cases, to areas where erosion-resisting grasses cannot be grown. Experiments conducted at Stillwater, Oklahoma, during the past few years indicate that concrete slabs cast on the ground, using inexpensive forms, can be used to construct baffles costing less than masonry or monolithic concrete.

Two different types of concrete slabs have been used in these studies. In the first experiment the slabs were 18 in wide and 3 in thick. They varied in length from $4\frac{1}{2}$ to 7 ft and were made with a V-notch on one side and a sharp edge on the other, similar to those shown in Fig. 1. The ratio of sand to cement was four to one. The slabs were placed in a vertical position on a curved foundation 8 in wide and 5 in thick. This foundation was reinforced with a $\frac{3}{8}$-in steel rod placed about one inch above the bottom of the concrete. The slabs were set in mortar to correct any irregularities in shape and to keep them from turning or slipping. They were tied together with a $\frac{1}{2}$-in steel rod. A hook made of $\frac{3}{4}$-in steel was placed near the center of the slab on each end of the structure. The steel rod was attached to these hooks. Soil was tamped between the end slabs and the bank, and tension was developed by placing one or more bricks between the rod and some of the center slabs. An apron was poured along with the footing. It was 3 in thick and reinforced with wire. The radius of an arc used to lay out a foundation will vary depending upon the width of the baffle.

In a second experiment concrete slabs $1\frac{5}{8}$ in thick and 18 in wide were used. Slabs 3 ft long were placed in the center of the structure, and slabs $4\frac{1}{2}$ ft long were used for the wingwalls. Two structures which were built in the spring of 1937, using the thin slabs, are shown in Fig. 2. The notch between the wingwall in these structures is $7\frac{1}{2}$ ft wide and 18 in deep. The cost of cement, sand, and reinforcing material to make the slabs, footing, and apron was \$6.00. An arch effect is obtained in this type of baffle if it is installed properly, and the stability of the structure will depend upon the durability of the steel rod which is placed on the upstream side of the slabs to hold them together.

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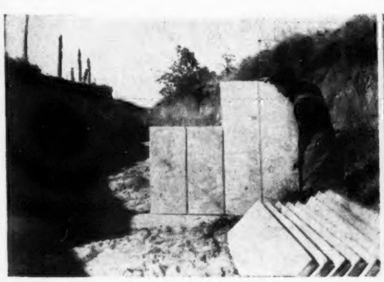
Some seepage occurred around the ends of the baffles, as shown in Fig. 2, because mortar was used to make tight joints between the slabs. This mistake was corrected in later installations. Narrow cracks occurring between the slabs will permit the drainage of excess water occurring on the upstream side of the structure and reduce the possibility of damage from ice pressure in the soil in a cold, wet climate. After the soil has settled against the wingwalls and a good growth of vegetation is established, water movement around the ends of a structure should not occur unless openings are made through the soil by burrowing animals, or cracks develop between the wall of the structure and the soil as a result of soil shrinkage during periods of drought.

Although the arch-type structure is economical to build and should give satisfactory results if designed properly, concrete slabs set in a straight line across a ditch would be easier to install under average conditions. Slabs for several experimental structures were made as a result of suggestions obtained from R. E. Kirkham, civil engineer in the Oklahoma Agricultural and Mechanical College. Each slab was designed to carry its own load. In these experiments the maximum length of the slabs was 4 ft 8 in. They were all cast on the ground as shown in Fig. 3. The slabs were 14 in wide and $1\frac{5}{8}$ in thick, except for the rib, which is approximately $2\frac{1}{2}$ in wide and $2\frac{1}{2}$ in thick. A few wide slabs with two and three ribs in them were made, and there is no reason why they should not be just as satisfactory as the narrow slabs unless a drainage problem should develop. In some instances a shallow trench was dug in the soil to prepare a form for the rib instead of using the galvanized iron trough, as shown in the illustration. Before the trough is completely filled with concrete, a $\frac{3}{8}$-in steel rod is placed so that it will be near the center of the rib. The flat part of the slab should be reinforced with wire to protect the concrete against failure from expansion and contraction due to temperature changes. No. 14 gage wire spaced 12 in apart was used in these slabs. One part of cement, two parts of sand, and two parts of limestone screenings varying from $\frac{1}{8}$ to $\frac{3}{8}$ in in diameter produced better slabs than a one-to-four mix using cement and sand.



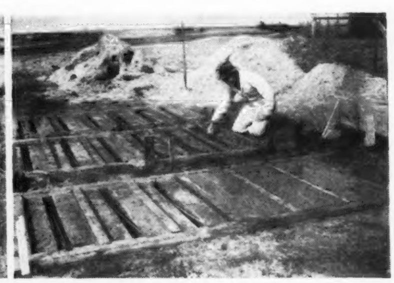
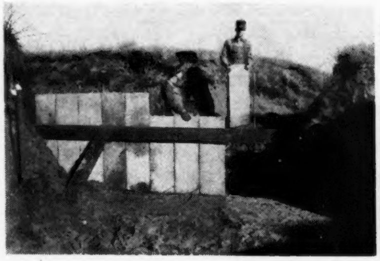


FIG. 1 (LEFT) PLACING CONCRETE SLABS ON A CURVED FOUNDATION TO OBTAIN AN ARCH EFFECT WHEN THE STRUCTURE IS COMPLETED. FIG. 2 (CENTER) TWO CONCRETE SLAB STRUCTURES IN A GULLY WHERE SOIL CONDITIONS WERE UNFAVORABLE FOR THE GROWTH OF GRASS. FIG. 3 (RIGHT) CONCRETE SLABS WITH A RIB ON THE LOWER SIDE, REINFORCED WITH A $\frac{3}{8}$-IN STEEL ROD, ARE MADE IN GROUPS IN INEXPENSIVE FORMS



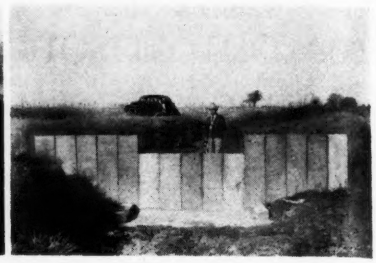


FIG. 4 (LEFT) CONCRETE SLABS ARE SET ON BRICKBATS TO HOLD THEM 2 IN ABOVE THE BOTTOM OF THE FOOTING AND ARE WIRED TO A PLANK TO HOLD THEM IN PLACE WHILE THE APRON AND FOOTING ARE POURED. FIG. 5 (RIGHT) THE CONCRETE SLAB STRUCTURE READY FOR THE FILL. THE WALL ON EACH SIDE OF THE APRON CAN BE RAISED, IF NECESSARY, TO PREVENT EROSION OF SOIL WHERE A GRASS COVER CANNOT BE OBTAINED

After a site is selected for a structure, an excavation about 3 ft wide is made across the ditch, and a trench for the footing is dug about 15 in wide and 8 in deep. This trench is connected with a spilling basin 2 ft longer than the width of the notch through which the runoff water will flow and as wide as the wingwall is high. A 2-in plank should be placed across the ditch and anchored firmly to hold the slabs in a vertical position in the center of the trench, as shown in Fig. 4. The first slab should be set on a brickbat near the center of the notch and checked with a level before it is wired to the plank. After all of the slabs are in position, the trench is filled with concrete, so that the lower end of the slabs are covered to a depth of 6 or 8 in. Very little concrete is needed in the footing near each end of the structure, because the pressure on each side of the end slabs will be very similar after the excavation is filled with soil. Short steel rods about 14 in long, with a sharp bend on each end, are placed in the footing from the upstream side of the structure. They should pass under the slabs near the rib in order to prevent the footing from cracking due to the cantilever effect produced by the soil pressure on the upper side of the wall. Concrete blocks may be needed on each side of the apron to control the churning effect of runoff water if a vigorous growth of grass cannot be established at the contact between the edge of the apron and the bank. More concrete should be used in the footing near the notch; consequently, a trench slightly tapered at each end would be more desirable than a trench with a uniform width. The joints between the concrete slabs should not be filled with mortar. Drainage is necessary to prevent seepage around the ends of the structure and to reduce damage which may occur from frost in wet cold climates.

Concrete slabs constructed with a rib on the back are distinctly superior to smooth slabs for two reasons. The presence of a rib seems to discourage burrowing animals, which frequently cause trouble when openings are dug along the wingwall of a mechanical structure and runoff water passing through these openings removes the fill. A rib with an open joint between the slabs to provide drainage also retards the movement of seepage water along the upper side of the wall, and washouts are less frequent as compared to structures having relatively smooth walls which do not restrict the flow of drainage water in narrow cracks formed by soil shrinkage.

The cost of material required to build the concrete slabs with ribs reinforced with a 3/8-in steel rod was 29 cents for slabs 4 ft 8 in long, and 16.5 cents for slabs 3 ft 8 in long. Sixteen of these structures have been installed, and cost records kept on all of them. The depth of the notch in all cases has been 12 in. This could be increased to 18 in at very little extra cost by making the wingwalls 6 in higher. The width of the notches has varied from 4 to 20 ft. Cost of material required to build a structure with a notch 6 ft wide using 5 slabs on each side for the wingwalls, as shown in Fig. 5, is approximately $10.00. The labor cost is approximately equal to the cost of material, depending upon the amount of excavation which may be required.

If taller structures are made, the thickness of the slabs should be increased and a larger steel rod should be used to reinforce the rib. If a concrete cap is used to eliminate the cantilever effect on the slabs, the ribs should be placed on the downstream side. No structures of this kind have been installed, although three installations have been made using slabs protected with either a concrete cap or a concrete beam placed on the lower side of the slabs. One important advantage of the slabs is that less concrete is required to build them and also the cost of forms is low as compared with material required for monolithic concrete installations. Another advantage which occurs when slabs are used is that a few of them can be made whenever time is available. Although the individual slabs are probably not as strong as monolithic concrete, these structures are entirely satisfactory for use in the development of water disposal systems for terraced land.

Since a mechanical structure is ready for use as soon as the concrete is set, it has a distinct advantage over a grass outlet ditch on areas where land values are high, because less space is needed for an outlet channel when mechanical structures are used. In many areas a type of grass may not be available or grass which will form an effective cover may be too aggressive for use in outlet ditches occurring in a cultivated field. Under these conditions the mechanical structure has a distinct advantage, because active overfalls can be eliminated and land which has already been destroyed by erosion can be utilized to develop a controlled outlet for drainage water.

Where several structures were used in the development of a water-disposal system for terraced land, the top of the notch in each structure was placed a few inches lower than the channel above the adjacent terrace ridge. The top of the apron in each baffle above the lowest one in a series, was level with the top of the slabs occurring in the notch of the first structure occurring downstream. Although the gradient in outlet channels will vary depending upon the volume of water which is carried, there is always some danger from undercutting at the edge of the apron if too much difference in elevation occurs between adjacent structures.

Contour Cultivation Studies

TESTS of contour ridging on a 15 per cent slope under simulated heavy rain ("Soil Conservation," July 1939) have been reported to show advantages over up-and-down-hill cultivation, either flat or ridged, including increased time before start of runoff, increased absorption of water, and decreased soil runoff. The contour ridges were truly on the contour, firm, reinforced by roots, and dammed by the plot sides to correspond to field damming at 6-ft intervals, representing ideal contour cultivation practice. Results were favorable to the contour cultivation as to runoff and infiltration, and strikingly favorable as to soil loss.

How to Recognize and Evaluate a Research Problem

By John A. Slipher
MEMBER A.S.A.E.

WE CAN agree, I believe, that investigation or research constitutes an organic part of our total endeavor in behalf of technology in agriculture. Corollary to that is recognition that further understanding of agriculture rests heavily upon advance in its researches.

To the inquiring mind, investigation implies the existence of a problem. Not all persons agree on what constitutes a problem. The farmer may look upon a faulty feature of some practice as being a distinct problem. Again, another may, with equal conviction, choose to challenge the soundness of that which is accepted as orthodox. Are both viewpoints valid?

Viewpoints Rather Than Answers. Preliminary to setting forth on a research program, just how shall one identify a problem? Is there a useful procedure, and can it be reduced to logic and order, or must the worker follow circumstance and opportunity? It is not my intention to give answers nor to offer dogmatic rules, which in use prove futile. Rather, I wish merely to discuss with you some considerations attending the identification of problems intended for investigation.

Two Sorts of Problems. At the outset, it might clarify our further thinking if we were to have in mind two broad sorts of problems. First is the *abnormal* sort, those offering features that are faulty, subnormal, or abnormal when appraised in terms of current standards. Second is the *supposed normal* sort. Of this type are situations or performance or efficiency that appear to be at par according to our current standards, but that are actually far beneath a possible, yet undiscovered level of attainment. A noteworthy example of this sort may be cited in the achievement of superior corn hybrids, an accomplishment of the last two decades. For an unsolved one, we need only turn to tillage—a gigantic monstrosity—the role and limits of which lie unexplored.

Those of the latter group display no earmarks of identification. They lie hidden, perhaps deep beneath the surface of our experience, as it were. Those of the first group impinge upon us so closely that their existence is obvious and sometimes monotonous.

By reason of the nature of human understanding, our experience furnishes the standards by which to judge and appraise. Such standards are varied, ranging from numerical values to casual observation, to belief, to unestablished expectation.

Grades of Identification. Our discussion is beset with difficulty for the plain reason that identification is an end point. It doesn't exist in tangible form, it is a thing to be built. Therefore, we can know it only by fabricating it in the form of ideas. To that end, we may enquire into each of four grades of identification, namely, (1) deceptive, (2) partial, (3) immature, and (4) mature, identification.

Deceptive Identification. In a situation of apparent simplicity may lurk deception. In practice, circumstances are sometimes nests of complex character. Especially is that to be expected in the field of agriculture where biologic, physical, and chemical processes often coexist. Because of that triple situation, some of the elements in the picture may not be readily identified. Passing by an innocent or obscure factor may have serious repercussions in a solution of the problem.

Moreover, since it is obviously beyond the scope of the investigator of a given problem to rediscover all past knowledge relating to and tying into his problem, some assumptions are necessary. Do we always safely appraise, recognize, and discard assumptions infected with error or falsity? Consistency passes for truth. Then, too, in a growing technology where knowledge is expanding in depth and range, much uncertainty can center around assumption. Unquestionably there is real occasion to recomb and sound out suspicious areas because familiarity and tradition blind us. And, after all, the accepted truth of yesterday may be the falsehood of today.

Escaping the foregoing dangers, identification is threatened with another, namely, the difficulty of keeping fact and inference apart. In the words of Faraday, "the philosopher should not be biased by appearance". The investigator's predicament is identical. Much of his knowledge of phenomena arises from the senses and hence is only knowledge of appearances. "Phenomena", Plato contended, "may not be true existences but only images". In any event, effort at identification needs to distinguish the shadow from reality.

Partial Identification. Expediency stands ready to becloud identification and give rise to a partial concept of the problem. Restrained by limited funds or a lack of time for carrying out the solution of the project, the investigator sometimes attempts to identify merely the part of the problem that he intends to work on immediately. The problem in its entirity—as an organic whole—remains unexplored and unmapped. On the other hand, were the identification made complete at the time, the current project might be strengthened and brought into proper organic relation to coprojects initiated later to complete the broad problem.

Another factor contributing to segmental identification lies in the existence of subject-matter lines represented by administrative departments. The scope of our problem may fall within a single department. To assume so can lead to a faulty identification. Roots of major problems do extend into the area of two or more departments. In fact, in analysis not a few problems may be found to consist of relationships between subject-matter fields. How, then, shall we respect the sacredness of departmental lines? What requires that we turn back at the departmental line? At best it's only a zone—man-made—a thing of convenience. Dare we forget that analysis is no respector of persons, but only of things?

Immature Identification. Aside from its horizontal extent just dealt with, a problem conceivably has vertical levels. Failure to recognize the full series of strata or generations of factors leaves one with an immature identifica-

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Paper presented before the research group at the annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June 19, 1939. Mr. Slipher is associate professor of agronomy (extension) at Ohio State University.

tion. Surface appearances or phenomena may be well removed from the deep-seated primary or first-generation factors. Penetrating the depths of the problem to establish the existence of successive generations of factors or processes is most certainly an arm of the identification procedure. The dynamic forces lie internal; their combined expression appears in outward manifestation. To illustrate the application of this reasoning, let us turn to the problem of overcoming failure of legume seedings. Suppose no identification of generations of forces had been attempted beforehand, but a test was undertaken in which seeds were (1) broadcast and rotary hoe applied on one plot, and (2) drilled with an alfalfa seeder on a second plot. On the first plot was found a satisfactory stand, and on the second, an indifferent sort. Are safe conclusions possible in this situation?

Had a prior identification been drawn up we would have seen in the immediate generation the factors of moisture, air, and temperature, with tilth and coverage in the supporting or parent generation. Early recognition of these should have afforded the investigator the basis for his experimental technique. The duty of the experiment proper would have been

1 To verify whether each factor did exert influence
2 To establish the direction of the influence of each factor
3 To measure the magnitude of the influence
4 To gauge the joint result of the several active factors.

There is yet another aspect of problem approach. It concerns sequence. In the absence of a full survey of the depth of a problem, suppose the worker were to stake out what appears a worth-while project, unaware, of course, of its deeper connections. For purpose of convenient example, we shall refer to the realm of tillage. There he may likely choose to study the efficiency of several soil-working tools for seedbed preparation. Surely the objective is a seedbed. But, alas, all seedbeds are not of like quality. Where will he turn for a standard seedbed? Its specifications are not available. Establishing the structural make-up of a seedbed would appear to be a prior problem—a primary one. An identification of the tillage problem in its entirety would have disclosed this sequence as well as other relationships.

Comparative Evaluation of Problems. Occasionally a thorough appraisal may resolve a broad-base problem into twin or parallel problems. To cite a case in point, we may refer to the farmer's problem of seeding winter wheat on land currently in standing corn. The normal practice consists of cutting and shocking corn in readiness for seeding of wheat on the date necessary to assure best wheat production. Ostentatiously, overcoming slowness of operations and reduction of costs through improved efficiency would appear to be the problem. But it has a counterpart, namely, overcoming the supposed impracticability of seeding in standing corn. Thus we have alternative problems.

A proper evaluation of such dual problems should result in the rejection of neither. The vital consideration is the identifying of features common to both, namely, labor, efficiency, obstacles, cost, and resulting crop yields. That permits bringing both to the same common denominator for the purpose of comparison. In passing, it is not amiss to remark on the significant fact that one factor in the picture has nearly vanished during the past five years, namely, the obstacle of "down corn". The unfailing erectness of stalks to be had in corn hybrids, which make up a progressively greater proportion of our corn acreage, suggests the advisability of a reappraisal of an old, perennial farm problem.

Tools to Identify the Problem. So far we have addressed the discussion to the distinguishing of characteristics of problems. But just how might we go about "staking out", so to speak, the boundaries of the problem? Then, too, by what device can we identify with confidence the strata in its profile? Alternate tools are available, namely, scientific analysis, or plain opinion.

Perhaps we should shy away from any mechanism that smacks of the scientific—the theoretical air. But really has scientific analysis a lesser place as the instrument for locating and defining the problem than is accorded it in setting up the research technique for its solution? What, may I ask, is identification but a type of research?

On the other hand, and in our anxiety to be practical and safe, suppose we shun the scientific way and turn to its alternative. Then we purpose to rely on outright opinion arising out of experience and casual observation of appearances. The method leaves the worker free to choose the so-called "most important" thing and call it a project. But how does one recognize what is "most important"? Like time, importance is temporary. It's large today, but shrunken tomorrow.

Dare the investigator speculate with theory? Would that square with practicality? Philosophy aims at an understanding of the realities behind phenomena. Technology and philosophy, therefore, do meet on a common ground. To look upon each as being in a sphere exclusively separate and apart from the other is to weaken our opportunity for added understanding. The speculating theorist takes nothing for granted; the would-be realist accepts some supposedly proven points. Neither alone is safe, but the combination is powerful.

By-Products from Scientifically Identifying a Problem. To stop at this point in our consideration would omit something of significance, I believe. The scientific method appraises the problem from within; the opinion method would view it from without. A full and deep appraisal of the problem is likely to lead to a research program as deep and as broad as the problem itself. Therein we find something of a challenge to our further thought; it suggests worth-while by-products. We may reflect on four such advantages arising from matured identification:

1 It affords a continuous, long-time program of related stages.

2 Sequence of the investigative undertakings would likely prove more logical and orderly.

3 About the large problem there is a certain forward-looking quality that is far-reaching. It lives in people's thinking and research has its public too.

4 It promotes attitude and develops breadth of understanding. Understanding stands as the end point—not knowledge, although the latter is necessary to a realization of the former.

While this paper lays no claim to an exposition of the scientific method nor to the techniques incident to its use, it does speak for its usefulness and product.

CONCLUSION—A CHALLENGE

In sketching a conclusion to this presentation, I should leave these ideas foremost, namely, (1) that skillful identification of the problem is no less a duty of research than is its solution, (2) that problems possess facial appearance, structural breadth and depth, (3) that the more penetrating tool for exploring the problem lies in the scientific method, and (4) that practicability—though sometimes an objective—is not a method. And lastly, and mostly, this paper presumes to invite, to provoke, to challenge thinking about problems in terms of the flesh and bones making up those problems.

Puddled-Earth and Rammed-Earth Walls

By Ralph L. Patty
MEMBER A.S.A.E.

EARTH HAS been used for building walls in several different ways. It has been puddled as a mud (usually mixed with straw or other fiber), molded into bricks, baked in the sun, and laid into the wall. This construction is known as "adobe", and it has been used extensively in southwestern United States and in Mexico. Another type of earth wall is built by puddling the soil and adding straw or some fibrous material and packing this mud between forms. The forms are built in the same way as for monolithic concrete walls. This construction is known as "poured adobe" and is not so common, although such buildings are occasionally found in the West. There are two other kinds of earth walls that have been used in Europe, and especially in England, known as "cob" and "chalk". The cob walls are made by puddling the soil, adding straw, and laying the mud on the wall in layers where it is tramped in place and the sides trimmed. Chalk walls are made of a chalky soil puddled as mud and either laid up in the same manner as the cob wall or molded into blocks and laid into the wall.

In all the above walls the earth is puddled as a mud. In building with *pisé de terra*, or "rammed earth", the soil is only moist. It is rammed mechanically or by hand into sections of heavy forms to make a monolithic wall. Building blocks can also be made in this way and laid up in the wall.

In order to determine the comparative strength of earth walls to carry a load when made from "puddled earth" and when made from "rammed moist earth", the South Dakota Agricultural Experiment Station made a carefully controlled study in 1937-38. Three base soils were used. Soil No. 1 was a fairly heavy clay soil with a total sand content of 10.36 per cent, by weight. Soil No. 2 was a medium sandy clay soil with a total sand content of 37.56 per cent. Soil No. 3 was a very sandy soil containing a total sand content of 74.82 per cent. The sand content was obtained by sieve analysis; all material retained on a 200-mesh screen being classified as sand. (The term "sand" as used in this article includes all aggregate which may range up to an inch or more in diameter.)

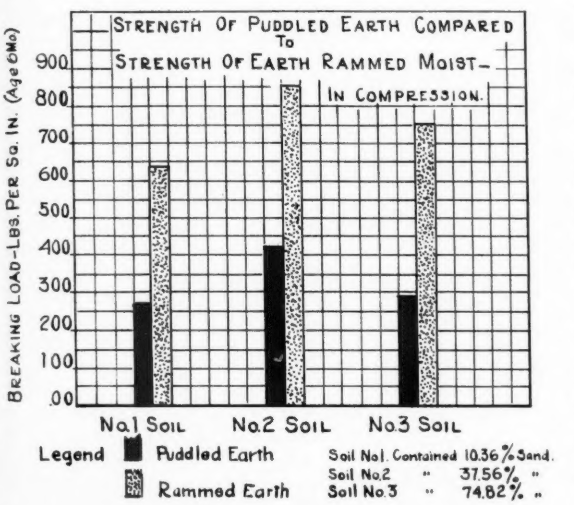
Twenty-four test pieces were made from each of the base soils. Twelve of these were made by the "rammed-earth" method using the optimum moisture for density under compaction. The other twelve pieces were made as "puddled earth" or mud, using the same consistency of mix as is used in the various methods of building mentioned above. This consistency is a mud just stiff enough to avoid slumping of the material as it is removed from the form. Straw was added to the puddled earth pieces at the rate of 122 lb of straw for each 1,000 lb of earth, which is the commonly recommended amount. The straw was cut in lengths of approximately six inches.

Cylindrical steel forms were used for making the test pieces. They were 8 in in diameter and 16 in high, and similar to the forms used for making test pieces of concrete. The rammed earth pieces were rammed in layers the same as for wall construction. The layers of loose dirt were weighed into the form so that the depth of the test pieces would be quite uniform when finished. The layers were rammed with an 18-lb hand rammer that is used in ordinary wall construction and with the ordinary intensity of ramming. The puddled-earth pieces were made by packing the mud into the form carefully with the hands. This is the method used by the Mexicans in making adobe brick. Slightly greater care was used in packing the test pieces than is the practice of the Mexicans in order that no voids be left in the piece due to careless packing. They were removed from the form immediately as is the practice in making adobe brick.

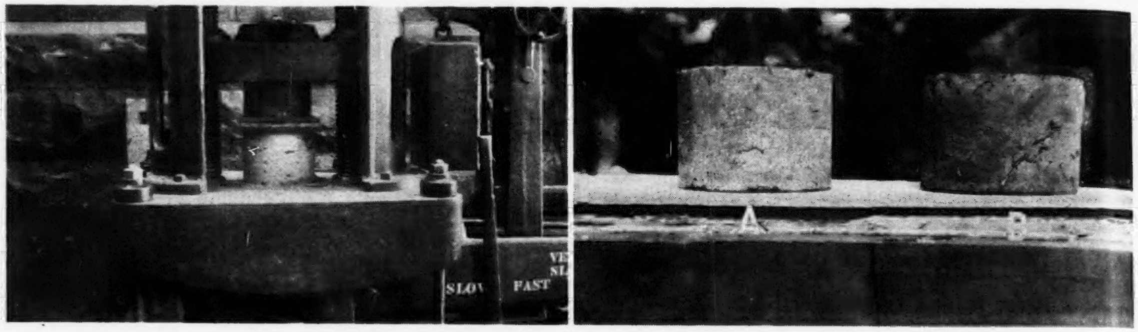
In order that the result be more definite, the test pieces of each soil were made in three different depths. Since adobe brick are usually made and tested in 4-in thicknesses, four test pieces were made of this thickness from each soil. Since rammed earth test pieces have usually been tested in 9-in thickness, four test pieces were made with a 9-in depth for each soil. A 9-in depth is the greatest depth of test piece that could well be made of rammed earth in a cylinder, as the 7 in of reserve space in the cylinder is necessary for the ramming process. An intermediate depth of 6 in was used for the other test pieces. A total of 72 test pieces were made in all, of which 36 were of rammed moist earth and 36 were made from the puddled earth or mud.

The test pieces were all stored in the laboratory for a six-months period under a temperature of 65 to 70 F, when they were tested to failure in a Riehle testing machine. At this age they were well dried out to constant weight, with the test pieces made from the No. 1 soil containing an average of $2\frac{1}{2}$ per cent of moisture; the No. 2 soil, $1\frac{3}{4}$ per cent, and the No. 3 soil, approximately 1 per cent of moisture. The average of the three soils in the puddled-earth test pieces lost 19.9 per cent of their original weight in moisture in drying out, while the average of the three soils in the rammed-earth test pieces lost 11.48 per cent of their original weight.

Prepared especially for publication in AGRICULTURAL ENGINEERING. Prof. Patty is chairman of the department of agricultural engineering, South Dakota State College.



This graph shows the relative crushing strength of puddled-earth as compared with earth material when rammed moist, in the tests at the South Dakota Agricultural Experiment Station



TESTING EQUIPMENT AND SPECIMENS USED IN SOUTH DAKOTA TESTS OF EARTH AS A BUILDING MATERIAL

(Left) An earth test piece under test for crushing strength in a Riehle testing machine. (Right) Block "A" is a specimen of earth rammed moist, while block "B" is a puddled-earth specimen. Puddled-earth specimens showed a crushing strength of only 43.2 per cent of the rammed earth specimens, an average of the 72 pieces tested

The average breaking load for the 4-in puddled-earth test pieces was 410 lb per sq in as compared to 973.7 lb for the rammed-earth pieces. For the test pieces with a 6-in depth, the average breaking load was 317 lb per sq in for the puddled-earth pieces as compared to 790 lb per sq in for the rammed-earth pieces; and for the test pieces with a 9-in depth the average breaking load was 248 lb per sq in for the puddled-earth test pieces as compared to 492.4 lb per sq in for the rammed-earth pieces. The average figures for all test pieces from the three different soils and for the three different depths show a strength for the puddled-earth type of construction equal to only 43.2 per cent that of the rammed-earth type of construction. The vertical bars in the accompanying graph show the comparative strength for each soil more clearly. The black bars measure the strength of the puddled-earth material while the mottled bars measure the strength of the rammed-earth material.

The reason for the difference in strength is unquestionably due to the difference in density of the two materials. The puddled-earth lost water equal to 19.9 per cent of its original weight as it dried. The original moisture in the puddled-earth material averaged 21.65 per cent, which was definitely too much moisture for optimum density and therefore too much moisture for optimum strength. Voids were left in the material when the water evaporated leaving a honeycombed structure.

OPTIMUM MOISTURE SIMILAR FOR EARTH WALL CONSTRUCTION AND FOR EARTH DAMS

It will be observed by those readers, who are interested in earth dam construction, that there is a very close analogy between earth wall construction and earth dam construction. The optimum moisture used for the greatest strength in wall construction for a particular soil will be the optimum moisture for that soil in securing density in earth dam construction. Proctor (field engineer, Los Angeles, Calif., bureau of waterworks and supply), in one of a series of articles on earth dam construction in *Engineering News-Record* for August 31, 1933, shows by a curve the relation between moisture in soils and the density of packing in the structure. The curve indicates that the voids in the packed earth not only increase as the moisture exceeds the optimum per cent, but that these voids increase in about the same amount with a deficiency of moisture. In other words, the voids in a soil under compaction decrease as the moisture increases up to the point of optimum moisture for that particular soil, and they increase in a direct ratio as the moisture is increased above the optimum amount for that soil. This of course is true in earth wall construction and is the reason for the greater strength of the rammed-earth material. There is one slight difference in the feasibility of soils for the two purposes. The soil showing the greatest strength for rammed earth work is not the most favorable for use. For instance, the No. 2 soil shown in the graph gives the greatest strength, but it will not resist weathering action as well as the No. 3 soil which contains 74.82 per cent total sand. Sand seems to be the most important factor in the resistance of an earth wall to weathering. It is also favorable to the successful use of paint coverings. Soil No. 2 will make a satisfactory earth wall if it is protected on the outside with a plaster or stucco covering. For earth dam construction, soil No. 3 would be slightly more favorable, but soil No. 2 would be entirely satisfactory when properly handled with the optimum moisture.

TESTING METHODS USED WITH EARTH TEST PIECES

In placing the load on earth test pieces with the Riehle testing machine, cardboard mats and sand cushions are used. Since no standard practice has been established for this work, the South Dakota station had to investigate this method carefully before using it. It has proven very satisfactory in showing comparative strength of test pieces at least, and probably gives an accurate result for them as well. Earth test pieces differ from concrete pieces in that they are not exactly level on top. The bottom will be level and true, but the top surface will not be entirely even, although care is used in ramming or packing them. Since the bottoms are true, the cardboard mats alone are found satisfactory for the bearing surface below. Two mats are used making a thickness of approximately 3/8 in. On the uneven top of the test piece fine sand, screened through a number 12 screen, is used. The sand is piled on top of the piece and carefully levelled off. Enough sand is used to give a thickness of at least 1/4 in at points of minimum thickness. Over the sand are then placed two cardboard mats of the same thickness as below. A heavy iron plate covering the top of the test piece is then placed on top and it is ready to take the load. The pieces of similar earth show a remarkably uniform strength when the nature of the material is considered. This is particularly true of the rammed earth pieces. Hundreds of them have been broken during the past eight years, and the uniformity of breaking loads, for similar test pieces, is quite remarkable. It is practically impossible to read the initial failure on these test pieces owing to their surface. Our interest has been in comparing the strength of one earth test piece with another, and for that reason the ultimate load has been quite satisfactory in the tests. Experience has shown that earth test pieces should not be tested for *(Continued on page 319)*

Thermal Characteristics of Electric Brooders

By John E. Nicholas and E. W. Callenbach
MEMBER A.S.A.E.

THE PRINCIPAL functions of an electric brooder are the conversion of electrical energy into heat and the efficient application of the converted heat, for the comfort of young chicks, to the limited area under the brooder canopy.

Insulation and partial prevention of heat dissipation into the brooder house, by means of curtains around the edge of the canopy, are two means for restricting electrically generated heat to the floor area under an electric brooder. The location, shape, heat capacity or connected load in watts, and arrangement of heating elements are factors limiting the amount and application of the available heat. Reflectors are also important considerations, and since control is absolutely necessary the presence of a dependable, automatic thermostat is essential.

Brooder canopies may be square, circular, or rectangular, with tops conical, gabled, or flat. Heating elements may be centrally located, or arranged around and near the edge of the canopies, either as single elements or in regular patterns. The elements may be exposed or partially or fully concealed. They may be either coiled resistance wires or strip heaters. Converted electrical energy may be applied through reflection, radiation, convection with forced air movement, or through direct contact. Ventilation may be natural or mechanical. This paper reports heat distribution under electric brooders representing all of the construction and operation variables specified except flat top.

Authorized for first publication in AGRICULTURAL ENGINEERING on May 8, 1939, as Paper No. 904 in the Journal Series of the Pennsylvania Agricultural Experiment Station. Mr. Nicholas and Mr. Callenbach are professor of agricultural engineering and professor of poultry husbandry, respectively, at the Pennsylvania Station.

The seven brooders studied are illustrated diagrammatically in Figs. 1 to 7. (The figure numbers correspond to the brooder numbers.) Both cross-section and bottom views are placed on the same center lines thus showing the relative position and shape of each heating element and the height of its suspension above the floor. For fan brooders, arrows indicate direction of air flow when brooders are operated with fans running. The cross section also shows the approximate amount of insulation used and its relative place in the construction of each brooder. The heat distribution curves, expressed as temperature in degrees Fahrenheit, are shown below the respective brooder in each figure.

The square brooder (Fig. 1) has a coiled wire heating element located at the periphery. The element encloses approximately two-thirds of the canopy area. Fig. 2 shows a circular cone brooder in which a coiled-wire element, protected by a perforated metal plate, is centrally located in a comparatively small area of the canopy. The circular brooder in Fig. 3 is practically a small heated canopy under a larger unheated canopy which overhangs the smaller one. The bottom surface of the overhang is covered with asphalt. The exposed, double-coiled elements are located under and within the insulated portion of the brooder, and the available heat is concentrated by a metal strip to which the legs are attached. This strip reaches about half way from the insulation to the floor.

Fig. 4 shows views of a rectangular brooder heated by two circular strip heaters, from which the heat energy is reflected downward by two inverted cones of bright polished metal. The brooder illustrated in Fig. 5 is heated by a coiled resistance wire arranged in a comparatively small circle and placed high so that the air currents developed by the centrally suspended fan are forced over it and pass down along the inner aluminum-coated surface of the canopy.

Fig. 6 shows a rectangular brooder which has an exposed rectangularly shaped coiled-wire element centrally located and protected by a wire screen. A curved, quarter-circle, polished-metal reflector attached back of and along

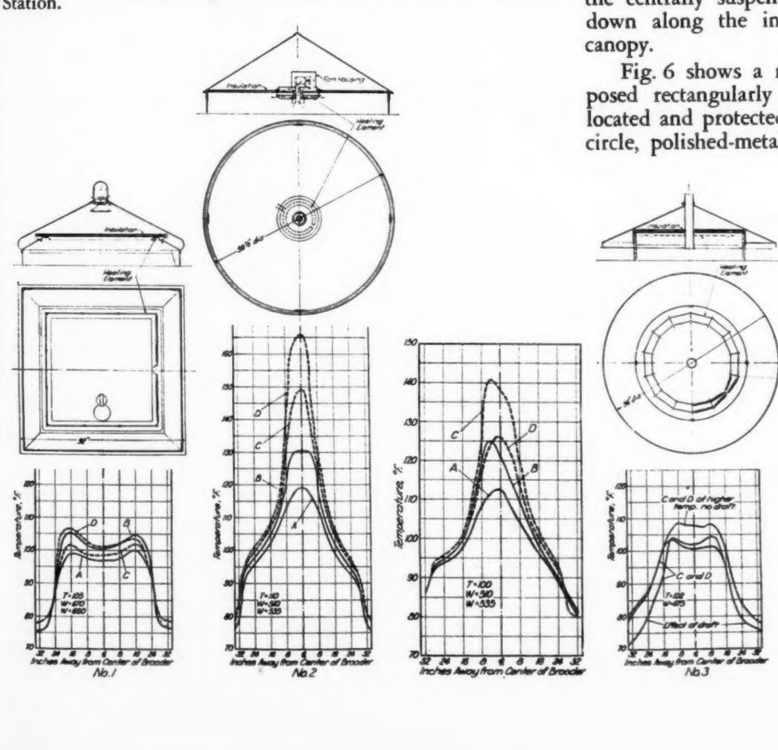


Fig. 1 (Left) Square brooder showing cross section, bottom view, and heat distribution during a cycle. Fig. 2 (Center) Circular brooder with conical shape showing cross section, bottom view, and heat distribution during a cycle, with thermostat setting at 110 F (left) and 100 F (right). Fig. 3 (Right) Circular brooder with conical shape without fan, showing cross section, bottom view, and heat distribution during a cycle, with thermostat setting at 102 F

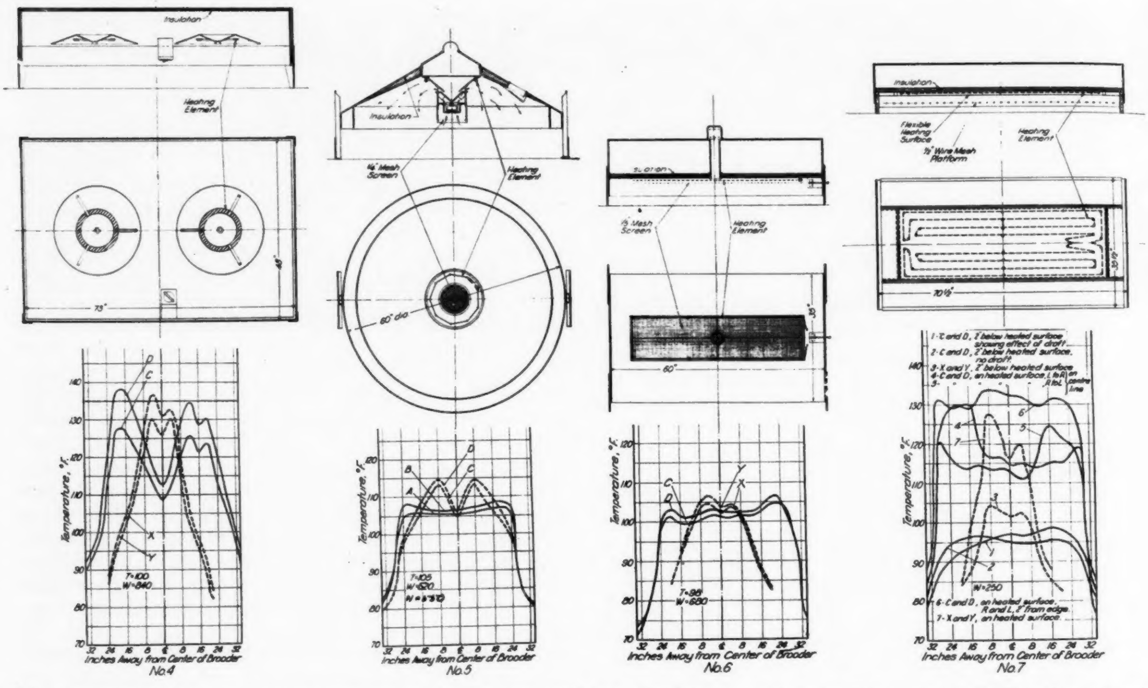


Fig. 4 Rectangular brooder showing cross section, bottom view, and heat distribution on the major axis curves C and D and minor axis curves X and Y, with thermostat setting at 100 F. Fig. 5 Circular brooder with conical shape showing cross section, bottom view, and heat distribution on a diameter with thermostat setting at 100 F. Curves A and B with fan running; curves C and D, fan idle. Fig. 6 Rectangular brooder showing cross section, bottom view without fan, having natural draft. Curves C and D indicate heat distribution on major axis; curves X and Y on minor axis with thermostat setting at 98 F. Fig. 7 Rectangular brooder showing cross section and bottom view. Heat distribution on the major axis at a point 2 in below the heated surface shown on curve 2. Similar distribution but without draft barriers shown on curve 1. Curve 3 is on a minor axis. Curves 4, 5, and 6 are taken on major axis on the heated surface. Curve 7 is on the minor axis

the length of the heating element aids in the distribution of reflected heat energy. The contact heat brooder shown in Fig. 7 has its heating element arranged as shown by the dotted lines. The element is covered by a flexible heating surface which is stretched approximately ½ in from the coil.

These brooders have the following ventilation auxiliaries: Brooders 1, 3 and 6 have air passages located in their centers at the peaks of the canopies. Brooder 3, shown without a fan, can be fan-operated by pulling out the chimney and inserting a fan under which a baffle plate is suspended. Brooder 2 has five ½-in holes in the brooder canopy which provide ventilation controlled by an adjustable grill in the fan housing. The brooder shown in Fig. 4 is ventilated by adjustable grills located in each end of the canopy. In brooder 5 fresh air passes through the peak of the cone and enters the brooder circulation system just above the fan. Brooder 7 has no means of ventilation.

All brooders were tested in the research laboratory at a room temperature of approximately 70 to 80 F (degrees Fahrenheit). Each brooder was placed, at floor level, on a piece of celotex ½-in thick, which served as the equivalent of litter generally used in practical brooding. To avoid floor drafts, each brooder was protected by a "fence" of 1x12-in boards located 1 ft from the edge of its canopy. Each brooder was in the lowest position possible, which is the general condition for day-old chicks. Temperatures under the hover were determined by means of thermocouples spaced 4 in apart and mounted on a 1x2½-in wood strip so that temperatures were measured 2½ in above the celotex floor. The temperatures of each brooder were allowed to reach thermal equilibrium under control of the thermostat set for initial conditions of brooding as recommended by the manufacturer and determined by the thermometer supplied with the brooder. In general, cycling was continued for at least 12 hours of operation before any temperature measurements were made.

Temperature measurements under each brooder which was equipped with an electric fan, were made both with and without the fan operating. Rectangular brooders were studied for heat distribution both longitudinally and transversely. The following legend is applicable to the charted heat distribution curves, except for the brooder reported in Fig. 7:

A — Current just on, fan running
B — Current just off, fan running

C — Current just on, without fan } Longitudinally for
D — Current just off, without fan } rectangular brooders

X — Current just on, without fan } Transversely for
Y — Current just off, without fan } rectangular brooders

Since brooder fans are in constant operation and represent an additional electric load, the connected load with and without the fan for the brooder thermometer temperature at which each brooder was operated are shown in the figures. For example, in Fig. 1 with the fan and brooder operating, there was a total connected load of W=690 watts. Without the fan the connected load was W=670 watts. The difference between these two connected loads is the amount of electrical energy supplied to the fan.

The temperature distribution for brooder 1, as shown

by curves A, B, C, and D, was made with a thermostat setting of T=105 deg as measured by the brooder thermometer. Since each brooder is automatic in operation, there is an "off" and "on" part in each cycle. As indicated previously, curve A represents temperature distribution, with the fan running, immediately after heating started, or during the "on" part of the cycle; curve B shows similar distribution immediately after heating ceased, or during the "off" part of the cycle. Curves C and D are for conditions identical to those measured by curves A and B, except that the fan was not in operation. As shown by all four curves, the floor surface under brooder 1 was heated quite uniformly and differences between temperatures recorded with and without the fan in operation are slight. Likewise the differences between the "on" and "off" parts of the cycle are almost identical with and without the fan in use.

Fig. 2 charts a heat distribution situation much different from that shown in Fig. 1. All curves show a definite and exceedingly high peak under the center of the brooder, immediately under the heating coils. The peak is exaggerated for measurements with the fan not in use. It is well to note, however, that the area affected by the peak, which is largely unusable by chicks in either case, is of approximately the same extent for all conditions measured. Because of the interesting nature of the temperature variations under brooder 2, two sets of readings were made, one with the thermostat set for a brooder thermometer reading of 100 F, the other for 110 F. The brooder for which data are plotted in Fig. 3 was operated without a fan which, while sometimes used, is not standard equipment of the unit. Since previous unpublished work has shown the fan to have little effect on heat distribution under this brooder, it was deemed unnecessary to determine readings for curves A and B. Curves C and D show two peaks of low elevation for points somewhat toward the center from the area immediately under the heating coils. The temperature from these points outward dropped very rapidly.

In order to establish the possible effect of a floor draft generated by cold air coming from a closed window about 4 ft from the brooder, the board fence was removed with results as shown by curve C, labelled "Effect of draft". The curve for the side of the brooder exposed to the draft is "pushed in".

In order accurately to determine conditions under brooders 4, 6, and 7, it was necessary to measure heat distribution on both major and minor axes (longitudinally and transversely). Curves X and Y represent temperatures taken transversely and are comparable to those shown by curves C and D longitudinally.

Fig. 4 illustrates heat distribution under a brooder equipped with two circular strip heaters suspended under polished reflectors. Temperature peaks under the heaters are noticeable along both axes. This brooder virtually represents two units such as illustrated in Fig. 2, squared and placed side by side.

Fig. 5 demonstrates a condition where the use of a fan affects decisively both temperature distribution and usable brooding area under the canopy. Peaks under the heating element, with a "trough" between, as shown by curves C and D plotted from readings without the fan operating, are completely eliminated when the fan is running, curves A and B. This brooder provided the most uniform heat distribution, and therefore the greatest curtain usable brooding area of all brooders studied.

Fig. 6 shows that the metal trough "quarter-circle" reflectors used with the brooder illustrated were highly effective in securing an even heat distribution longitudinally under the center of the canopy. Since there is no heating element across the minor or short axis of the brooder, the two slight temperature peaks under the closely placed elements and the rapid sliding off of temperature to the sides of the brooder were expected occurrences.

Fig. 7 presents curves for the only "contact-heat" brooder used. This brooder was also the only one not equipped with a curtain, a thermometer, an attraction light, or a pilot light. All curves are for temperatures recorded with current on. Curves 1 and 2, for the major axis, are comparable to curves C and D ("Effect of draft") and curves C and D ("no draft") as shown for the brooder diagrammed in Fig. 3. For brooder 7, however, the temperature "leaning", curve 1, is noticeable from one end of the brooder to the other. The absence of a curtain is probably responsible for this situation and emphasizes the necessity of a draft barrier in the successful operation of an electric brooder. Curves 4 and 5 show temperatures obtained on the flexible pad surface which is the effective heating element for this brooder. The variation in these curves is probably due to a slight shifting in relative position of the thermocouples and heating element when the brooder was turned 180 degrees (end for end) in order to obtain readings with both ends exposed to the possible influence of the window, even though the fence barrier was in use. Curve 6 is comparable to curves 4 and 5 but is for readings taken near the edge of the heated pad (*not* the edge of brooder canopy). Its uniformity, in contrast to curves 4 and 5, is due to the distribution and spacing of the heating element.

Curves 3 and 7 for the minor axis are similar to curves 2 and 4 or 5, respectively, for the major axis. It should be noted that both longitudinally and transversely there is a temperature difference of 20 to 30 deg between the contact pad and the air 2 in below.

SUMMARY AND CONCLUSIONS

1 The thermal characteristics of seven electric brooders representative of practically all known variations in construction, ventilation, and heat distribution were studied.

2 Diagrammatic cross-section and bottom views of each brooder are presented in Figs. 1 to 7, respectively.

3 Heat distribution, as measured by temperatures determined at definite and regularly spaced locations under each brooder, is also charted in the figures. All curves, except the three plotted in Fig. 7, show temperatures $2\frac{1}{2}$ in above a half-inch celotex pad which was substituted for the usual brooder house litter.

4 Usually the thermostat settings were those recommended by the manufacturer and measured by the thermometer supplied with the brooder.

5 Connected loads, with fans not running were 670, 510, 475, 840, 520, 680, and 250 watts, respectively, for brooders in the order as numbered. With fans running, brooders 1, 2, and 5 pulled 690, 535, and 550 watts, respectively.

6 From a heat distribution standpoint, fan operation of brooder 1 was of little value. In brooder 2 the fan served to reduce the otherwise excessive temperature immediately under the heating element. In brooder 5 the fan was essential and, when running, provided the most uniform temperature situation under any of the brooders studied.

7 Heat distribution under an electric brooder is largely determined and limited by (a) shape, location, and distribution of heating element; (b) relative position of and application of air movement generated by a fan; (c) kind, size, position, and location of reflectors, and (d) application of heat by radiation or contact, the latter also probably varying with the material used.

A Report of a Silo Survey

By Charles H. Reed

ON A survey, made in 1938 for a graduate thesis, New York farmers were visited, their silos inspected, pictures taken, questions asked the farmers about the service of the silos, and a record kept of the visits. Records were taken on 170 silos. Since this survey has been made, a number of other silos have been inspected, and I have been on the lookout for silo histories, but to date have not found any silos which could give a better record of service than those found in the original survey.

A study of the survey reveals some interesting facts about concrete stave silos. The average age of the 39 concrete stave silos included in the survey was 9 years. Of these 39 silos, 9 were less than 5 years old and still had a serviceable inside coating. One 10-year old concrete stave silo still had a serviceable, but soft inside coating. On all other concrete stave silos, 5 years old or older, the inside coating had peeled or corroded off, at least near the base, leaving the exposed staves to be corroded by the silage juice. The three oldest, 21, 20, and 18 years, were in very poor condition, probably due to the combined action of the weather and the silage juice. Apparently the inside coatings were more resistant to the action of the juice than were the staves themselves. This might be expected, as usually the coating is of a richer mixture of cement than are the staves, and sometimes it contains a waterproofing.

None of the concrete stave silos in this survey were reported to have been filled with anything but corn silage. When this type of silo is filled with grass or legume silage, the question arises, Will not this silo have a much shorter life than when filled with corn silage? The following facts would seem to apply: Grass or legume silage is usually more saturated with juice; sometimes it has a greater pH concentration than corn silage, and the New Jersey Agricultural Experiment Station reports[1] that it exerts an average of two and one-half times as much pressure as corn silage, or nearly one-third as much as water.

In both the tile masonry and the concrete silos the amount of corrosion varied inversely with the distance from the base, from which one might conclude that the rate of corrosion is dependent upon *(Continued on page 319)*

Paper presented before the Farm Structures Division at the annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June 20, 1939. Mr. Reed is a graduate student in agriculture at Cornell University.

[1] AGRICULTURAL ENGINEERING, June 1939, Vol. 20, no. 6, pp. 277-230.

(1) TWO 18 BY 40-FOOT TILE STAVE SILOS. (2) A 33-YEAR-OLD HOME-SAWED WOOD STAVE SILO (RIGHT) AS SOUND AS WHEN NEW. REPAIRS CONSISTED OF TIGHTENING HOOPS AND GUY WIRES. (3) OUTSIDE VIEW OF 20-YEAR OLD CONCRETE STAVE SILO. (4) LEAKAGE FROM CORN SILAGE THROUGH A TILE MASONRY SILO. (5) INSIDE VIEW OF DISINTEGRATION OF 21-YEAR-OLD CONCRETE STAVE SILO. (6) A 23-YEAR-OLD TILE MASONRY SILO STARTING TO CRACK OPEN. THE CRACK WAS PLASTERED UP PREVIOUS TO LAST FILLING. (7) INSIDE VIEW OF CEMENT MORTAR JOINTS AFTER 12 YEARS OF SERVICE

A Soil Moisture Meter

By F. E. Staebner

MEMBER A.S.A.E.

THE IMPORTANCE of an effective and rapid method of determining the need for irrigation, i.e., when the soil is dry enough to require additional water for the growing crop, has long been recognized. During the summer of 1935 the Bureau of Agricultural Engineering worked on the development of a device that would automatically indicate the relative need for irrigation at any time. After starting the work, a "soil moisture meter" based on the same principle of operation, upon which the Bureau was working, was brought out commercially, and the Bureau obtained one for testing under field conditions.

This meter depends upon the tendency of water films to move from wetter to drier surfaces actuated by surface tension. The meter consists essentially of a water-filled porous bottle and a vacuum gage to measure the "vacuum", or the extent to which the pressure in the porous bottle has been reduced below atmospheric pressure. When the soil surrounding the bottle is dry, water will move outward into the soil through the porous sides of the bottle, thus tending to establish a vacuum in the bottle. If the soil becomes wet, either from precipitation or irrigation, water is expected to move the other way. The change in pressure in the bottle is read on a vacuum gage.

The meter was set up in a check plot in an experimental strawberry field at Willard, North Carolina, the bottle being set with the center of its porous side walls at a depth of 10½ in below the ground surface. The general nature of the apparatus and its installation is shown in Fig. 1. The small metal tube that apparently connects the vacuum gage and porous bottle contains an anti-freezing solution and really connects the vacuum gage with a thin-walled rubber sack within the bottle. The remainder of the space within the bottle is normally filled with water. When replenishment is necessary, additional water may be supplied through one of the two short tubes attached to the bottle, the other one being used for the release of trapped air. These tubes are kept tightly sealed, except when water is being artificially added to the bottle.

The meter was installed in May 1935 and approximately three months allowed for the soil to settle around the porous bottle. No calibration of the meter was made at the time of setting other than to determine the dial reading at the start. This proved to be 0.2 cm where it should have been 0.0 cm. All readings were corrected by that amount. From other data it appears that the meter was set too deep in the ground to encounter rapid moisture changes. Strawberry plants do not seem to deplete the moisture 10½ in from the surface at a rapid rate.

Fig. 2 shows in detail the changes in meter readings that took place in late September and early October 1936. At this time the condition of the soil changed from fairly dry to fairly wet and the meter readings correspondingly decreased. Fig. 3 shows also in detail the meter readings during a twenty-day period in May 1937 when the soil was changing from a fairly wet condition to a rather dry one. Correspondingly, the meter readings increased, the change being from 6.8 at 8:10 a.m. on May 6 to 24.7 at 4:35 p.m. on May 27, or a total of 17.9 cm on the meter gage.

The soil of the experimental area is rated by the U. S. Soil Survey as Norfolk very fine sand. The field-carrying capacity of the subsoil appears to be about 18 per cent. Samples of soil for the determination of moisture content were taken from time to time in the same plot. These samples were taken in connection with other work of the investigation. The time interval between samplings varied from two to three days during the most active part of the spring harvest season to a couple of weeks at the extreme ends of the growing season in the spring and fall. The most common interval, however, was one week. These samples were taken always from three bore holes spaced one-third of the length of the plot apart and each bore hole in a different row. The meter was set in the center of row No. 3 of a six-row plot. The soil moisture samples were taken from rows 1, 2, and 3 until about the end of July, at which time it became desirable to step over first into row 4, then subsequently into the remaining rows of the plot. By the system of soil sampling location used, at each successive sampling the bore hole in each row was located about 2 ft to the west of the last preceding sampling location. When the end of a row was reached the next sampling was taken from the easterly end of the nearest row which had not then been used—row 4, row 5, and row 6 in order. By this procedure, the distances which separated the soil moisture meter from the bore holes was about 18, 18, and 52 ft, or an average of 29 ft at the start; 35, 3½, and 35, or an average of about 28 ft at a later time; and 18, 19, and 53 ft, or an average of 30 ft under an extreme condition.

The soil samples here considered were taken from the 9 to 12-in depth layer of soil, which places their center at a distance of 10½ in below the ground surface. This is the same depth at which the center of the porous bottle, the active part of the soil moisture meter, was set, as previously noted.

Accordingly, it was felt that both the meter and the soil samples should indicate approximately the same changes in moisture content. This is not intended to imply that the meter and the soil samples could be expected to consistently and continuously indicate the same changes in moisture content. It is very much to be doubted that another set of three soil moisture samples would consistently and continuously indicate the same moisture content as the first set that was taken. It was, however, felt that if the field became notably wetter or notably drier as time went on both determinators would indicate it.

Fig. 4 shows by the heavy lines the relationship between the soil moisture percentage of the 9 to 12-in depth

Mr. Staebner is drainage engineer, Bureau of Plant Industry, U. S. Department of Agriculture.

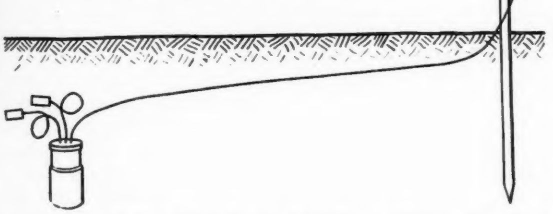
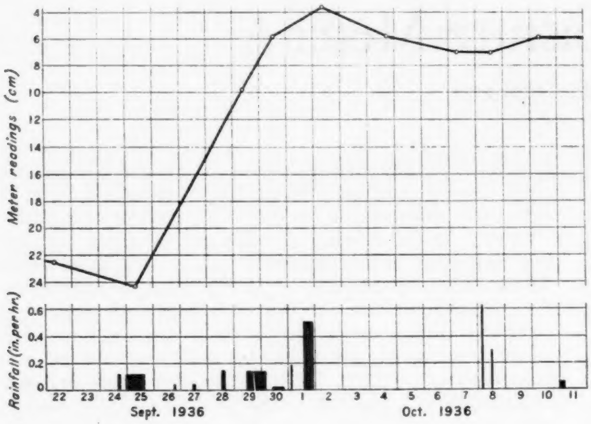
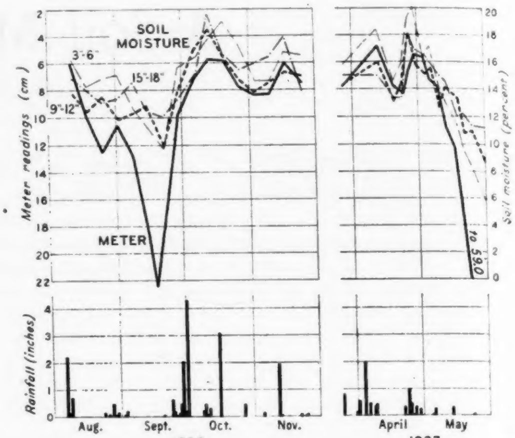
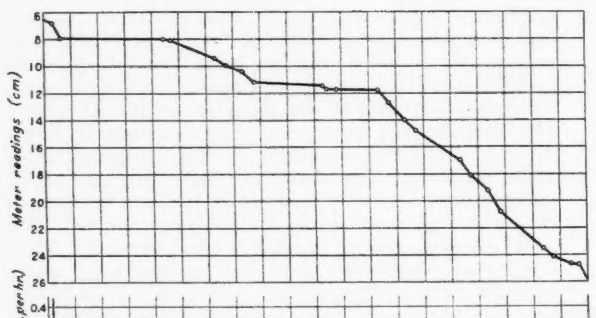



FIG. 1 THE ROGERS' PATTERN SOIL MOISTURE METER AS INSTALLED







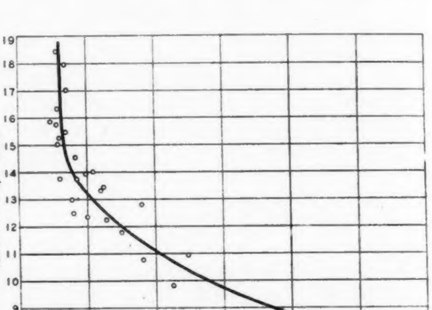


Fig. 2 (Upper left) Observed soil moisture meter readings during a twenty-day period with considerable rainfall. Fig. 3 (Lower left) Observed soil moisture meter readings during a twenty-day period of considerable dryness. Fig. 4 (Upper right) Observed soil moisture meter readings as related to observed soil moisture percentages and rainfall. Fig. 5 (Lower right) Graph of soil moisture meter readings vs. soil moisture percentages

layer of soil, as determined by ovendried soil moisture samples and the readings of the soil moisture meter. As mentioned previously, the curves only connect observed plotted points and do not indicate the variations between soil moisture determinations or the meter readings. Had a recording vacuum gage been used a continuous record might have been obtained.

The two light lines in Fig. 4 are the soil moisture percentages as determined by ovendried soil moisture samples for the 3-in to 6-in depth layer and the 15-in to 18-in depth layer. Unfortunately the data for the layer immediately above or below the 9-in to 12-in depth is not available. Fig. 5 shows the relationship between the soil moisture percentages of the 9 to 12-in depth layer of soil, as determined by ovendried soil moisture samples and the readings of the soil moisture meter. This curve shows the tendency of the meter to give consistently higher readings as the moisture in the soil becomes depleted.

With this soil moisture meter each setting will require a calibration to determine the point at which irrigation is needed. This may best be accomplished by taking a few sets of soil moisture samples nearby and determining their moisture percentage in the usual way. Doubtless the experienced irrigator or farm operator would in many cases determine by trial and error at what point on the meter dial irrigation should begin, and the inexperienced irrigator would use this point as his guide in deciding when water is needed.

From the data at hand, it appears to be a characteristic of this type of meter that the meter readings increase or decrease much more rapidly than the soil moisture percentages when the moisture in the soil is below a certain amount.

The author desires to thank M. R. Lewis, agricultural engineer, and Colin A. Taylor, associate irrigation engineer of the Soil Conservation Service, and Dr. J. R. Furr, physiologist of the Bureau of Plant Industry, for their painstaking review of earlier manuscripts of this article on the basis of which extensive alterations have been made.

The meter investigated is a Rogers' pattern soil moisture meter purchased from A. Gallenkamp and Company, 17-29 Clifton Street, Finsbury Square, London E. C. 2, England.

Footprints of Roman Agriculture

THESE footprints consist of the buildings of great Roman cities and towns, some of them excavated or in the process of excavation; others are still buried in the tombs of time, covered by erosion of the land which formerly fed them. There are also great aqueducts, cisterns, wells, tunnels, terraces, paved roads, covered sewers, canals, grist mills, check dams for diverting or spreading waters, desilting basins and reservoirs, innumerable stone olive presses often in areas devoid of trees, and, interestingly, one single section of old olive tree culture whose gnarled trees still grow in basins where Romans had planted them at least 14 centuries ago.—*W. C. Lowdermilk, in "American Forests."*

A Report of a Silo Survey

(Continued from page 316)

the quantity of silage juices at different levels. There was noticeable corrosion of all concrete silo foundations and of monolithic concrete silos, even after a few years of use. With good quality reinforced concrete the loss of an inch from the walls was not a serious problem in the foundation and monolithic silos because of the thickness of the concrete. In some concrete pit foundations there seemed to be less disintegration below a point where the outside moisture might seep in through the wall. This slower rate of disintegration is possibly accounted for by the fact that the minute cells in the concrete were already filled with moisture from the soil, thereby diluting the silage juice and also permitting less absorption of juices.

Considering the chemistry of concrete, the above statements are not too surprising. According to Hool and Johnson[2], the composition of properly set portland cement is as follows: 36 per cent $CaO\text{-}SiO^2\text{-}H^2O$, 33 per cent $2CaO\text{-}SiO^2\text{-}H^2O$, 21 per cent $3CaO\text{-}Al^2O^3\text{-}H^2O$. The hydrogen of even a weak dilute acid will replace the calcium and thus neutralize the lime compounds of the cement in the inside surface coating, and in the concrete, thus causing disintegration.

With the above facts in mind, this question arises: If the concrete stave silo is to give more years of service, with any kind of silage, must not an acid-resisting concrete or an economical, permanent acid-resisting coating be developed and used? Concrete stave silo manufacturers realize this and are trying to find the solution. Some of the attempts include coatings of portland cement wash or plaster, magnesium fluosilicate, linseed oil, and cumar. One manufacturer has advertised a protective wax surface coating, impregnated or cast with the stave at the time of manufacture. Another company casts a tile facing on the stave. A positive solution of this problem is needed.

I should like to mention what the survey showed about tile silos. There were 28 tile masonry silos of the Natco and Kalamazoo type ranging in age from 6 to 26 years, with an average age of 16 years. In none of these silos were there indications of tile corrosion—but in three the tile were crumbling badly, probably due to inferior quality tile. The cement mortar joints in every one of these silos had been corroded. In ten silos, with ages ranging from 9 to 26 years, it was possible to see daylight between the tile. The slightest leakage of silage juice in tile masonry silos with holes such as these, corrodes the iron reinforcing rods which are between the tile. A 23-year-old tile silo with many joints entirely gone has started to crack open, probably due to the corrosion of these rods. Do not these observations indicate that if the tile masonry silo is to be a permanent structure, the cement mortar joints must be protected from the silage acid or an acid-resistant mortar must be used?

The tile stave silo introduced into the Middle West about ten years ago and recently introduced into New York state, has a decided advantage over the tile masonry silo because of the absence of cement mortar joints, and because the hoops are on the outside. A process for removing air from the clay now used in manufacturing tile may prevent weathering.

The survey showed that one-fourth of the owners of steel silos expected to and were actually caring for their silos by coating the inside with old crankcase oil every year before filling, thus preventing the corrosion of zinc and steel. Possibly a similar practice may be a solution for the concrete stave silo problem. Many new steel silo owners believed that galvanized and copper-bearing steel would not rust or be corroded.

The most common building material for silos in New York state is wood, which, as we know, is not corroded by acids[3]. From a study of the data taken on this survey and from the inspection of these silos, we believe that the blowing over and collapse of wooden silos in New York state can be entirely overcome by proper construction and care, and that rotting, even at the base, can be almost entirely prevented by proper construction.

[2]Hool and Johnson, "Concrete Engineers Handbook," McGraw-Hill Book Co. 1918.

[3]R. S. Williams, "An Introduction to Organic Chemistry," D. Van Nostrand Co. Inc., New York 1927.

Puddled-Earth and Rammed-Earth Walls

(Continued from page 312)

strength until they have been held in the laboratory for a period of at least six months. The strength at this age will be considerably below maximum. A former study (See *Engineering News-Record* for July 9, 1936) on the effect of age upon the strength of earth test pieces showed an increase of 40 per cent in strength at the age of two years over the strength at the age of six months.

(EDITOR'S NOTE: Space did not permit including with this article a rather extensive table showing comparisons of strength in compression of test pieces of both puddled earth and rammed earth. This table may be obtained, however, in the new revised edition of the South Dakota Station bulletin No. 277. Address Prof. R. L. Patty, Brookings, S.D.)

Manufacture and Sale of Farm Equipment and Related Products: 1938

NUMBER OF ESTABLISHMENTS. There were 1,120 manufacturers, with 1,232 establishments, who submitted reports for 1938; 1,015 manufacturers, with 1,116 establishments, for 1937; and 1,005 manufacturers, with 1,103 establishments, for 1936.

DECREASE IN PRODUCTION. The total value of farm equipment and related products manufactured in 1938 shows a decrease of 15.5 per cent as compared with 1937. Decreases in value from 1937 appear for all groups except harvesting machinery and machines for preparing crops for market or for use, which showed increases of 53.5 and 10.3 per cent, respectively. Decreases in value appearing for other groups are as follows: Plows and listers, 18.8 per cent; harrows, rollers, pulverizers, and stalk cutters, 20.1 per cent; planting, seeding, and fertilizing machinery, 26.4 per cent; cultivators and weeders, 24.1 per cent; haying machinery, 26.0 per cent; tractors, 26.9 per cent; engines, 26.1 per cent; farm wagons and trucks, 48.7 per cent; and miscellaneous farm machines and equipment, 8.3 per cent.

SALES STATISTICS. The combined value of sales for domestic use and for export differs more or less from the total value of the year's production, due to the fact that the production statistics cover the products manufactured during 1938, while the sales statistics cover the sales made during 1938, regardless of when the items were manufactured. In 1938 the production exceeded the sales (domestic and export) by $7,364,177, in 1937 by $8,807,031, and in 1936 by $41,137,785. Of the total volume of sales for 1938, 84.7 per cent represented domestic sales and 15.3 per cent export sales; in 1937 the domestic and export sales represented 88.8 per cent and 11.2 per cent, respectively, and in 1936, 91.7 per cent and 8.3 per cent.—*From U. S. Department of Commerce, Bureau of Census report.*

NEWS

North Atlantic Section to Meet on Long Island

PRINCIPAL speakers for the yearly meeting of the North Atlantic Section of the American Society of Agricultural Engineers, September 12, 13, 14, and 15 at Farmingdale, Long Island, New York, have been announced by the committee arranging the program.

A. A. Stone will preside at the opening session, Tuesday afternoon, September 12. Director H. B. Knapp, of the New York State Institute of Applied Agriculture, will make a brief welcoming address. J. S. Webb is to present a message as chairman of the Section.

"'Ultra' in Lamps and Lighting" is to be the subject of a paper by Dr. Buttolph and L. C. Porter. Roger B. Whitman, columnist and author, will talk on "First Aid to the Ailing Farm Home." His remarks will end the program for the first afternoon.

Roundtables on power and machinery, led by M. G. Huber, and on rural electrification, led by Geo. W. Kable, are scheduled for the first evening.

"The Man Who Wanted the Earth Lost It", according to C. A. Frye, who will lead an hour of discussion on soil erosion control Wednesday morning, September 13. C. D. Leiter is the speaker for a water-supply topic, entitled "A Little Water Goes a Long Way." F. M. Wigsten is to handle the subject of "Quick Freezing on the Farm."

D. C. Sprague will talk on professional training under the title "The 'Kids' of Today Are the Agricultural Engineers of Tomorrow if We Start Them Right."

Harry Garver, supported by W. T. Ackerman and W. C. Krueger, is scheduled to explain the "U.S.D.A. Rural Electric Research Survey". L. F. Livingston is to talk on recent developments in the industrial use of farm products.

A speaker has not yet been announced for a talk on the purpose of the eastern regional research laboratory of the U. S. Department of Agriculture.

A soil conservation roundtable led by L. F. Livingston and C. A. Frye, and a farm structures roundtable led by W. C. Krueger will be held on Wednesday evening.

Subjects on the program for Thursday, September 14, have been changed somewhat since the preliminary announcement, and now include "One-Story Barns," by J. S. Schaffhausen, "Free Air Where You Need It Most in Barns and Farm Buildings," "Lessons Learned from a Hurricane in New England," "Farming High-Priced Land and Making a Profit," "Grass Farming," by H. E. Besley, and "New Farm Machinery, and How to Keep Nuts and Bolts from Falling Off the Old," by M. G. Huber. A business meeting of the Section is to be held at the conclusion of this session.

K. J. T. Ekblaw, president of the A.S.A.E., is to make the banquet address. A banquet entertainment feature listed as a spellbinder is Frank (Bring 'em Back Alive) Buck.

Five groups of exhibits at the Fair are indicated as of special interest to agricultural engineers. In the vicinity of the electrified farm are also the exhibits of home building, home furnishings, gas, the Town of Tomorrow, Johns-Manville and American Radiator. The "Avenue of Patriots" includes the Science and Education Building and the Perisphere and Trylon. Near the du Pont exhibit are also U. S. Steel, industrial science, Carrier Corp., General Electric, petroleum, electric utilities, electric products, and Westinghouse. Centered around Firestone's "Farm on Rubber" are the exhibits of Allis-Chalmers, John Deere, J. I. Case, International Harvester, Minneapolis-Moline, Iron Age, New Idea, Ford, General Motors, Goodrich, and the railroad exhibit. The fifth group includes the international exhibits. Arrangements are being made for specially conducted trips through many of these centers of interest for the North Atlantic Section Group.

Entertainment for the ladies present will include attendance at one of the men's meetings of general interest, a reception by ladies of the Institute Campus Club, a tour of the Institute flower gardens and greenhouses; trips to New York City for shopping, theater, or the World's Fair, a trip to noted estates and formal gardens on Long Island, a trip to the ocean at Jones Beach, the banquet Thursday evening, and the World's Fair on Friday with the men.

Requests for room reservations should be sent at once to A. A. Stone, New York State Institute of Agriculture, Farmingdale, N. Y. Reservations will be made in the order received, except that preference will be given to members bringing their wives and requesting reservations before September 1. The dormitories have all double rooms which will be occupied by two persons. Beyond the capacity of the dormitories, men will be quartered in the gymnasium, on single dormitory beds with spring mattresses.

Persons desiring hotel accommodations may secure them at the Hotel Huntington, Huntington, N. Y., about 12 miles from the Institute.

Nominations for Medal Awards Invited

IN ACCORD with the rules governing the award of the Deere and McCormick gold medals, the Jury of Awards of the American Society of Agricultural Engineers announces that, up to October 1, it will receive from members of the Society nominations of candidates for these two awards for the year 1940.

Members of the Society nominating candidates for either award are requested to keep in mind the purpose of each medal and formulate their nominations accordingly. The John Deere medal is awarded for "distinguished achievements in the application of science and art to the Soil," which citation is interpreted to cover more than a mechanistic concept of engineering, and to include chemistry, physics, biology, and any other science and art involving the soil, the "application" being susceptible to "evaluation by the engineering criteria of practicality and economic advantage." The Cyrus Hall McCormick medal is awarded "for exceptional and meritorious engineering achievement in agriculture", the citation being interpreted to mean the total achievements of a continuing career or to any single item of engineering achievement, and to apply equally to all special fields and types of engineering in agriculture.

The Jury of Awards desires that members of the Society consider it their duty and obligation to give serious thought to the matter and nominate for either or each of these awards the men they believe to be most worthy of the honor. Each nomination must be accompanied by a statement of the reasons for nominating the candidate and of the qualifications of the nominee, including his training, experience, contributions to the field of agriculture, a bibliography of his published writings, and any further information which might be useful to the Jury in its deliberations.

The Jury will accept and consider nominations received on or before October 1, and these nominations should be addressed directly to the chairman of the Jury of Awards—Mr. Chas. E. Seitz, Virginia Polytechnic Institute, Blacksburg, Virginia. It is also requested that seven copies of supporting information for each nominee be furnished, one for each member of the Jury.

Additional information on the history, significance, and description of these medals will be found in AGRICULTURAL ENGINEERING for May 1932 (McCormick Medal) and October 1937 (Deere Medal).

Industry Seminar Held Sept. 11 to 15

REGISTRATION is practically complete for the 1939 A.S.A.E. Industry Seminar to be held September 11 to 15, according to E. W. Lehmann, chairman of the committee in charge of this activity.

Cooperating manufacturers whose plants will be visited and operations studied this year are the Allis-Chalmers Manufacturing Company, Caterpillar Tractor Company, Deere and Company, International Harvester Company, Minneapolis-Moline Power Implement Company, and Oliver Farm Equipment Company.

Schools offering a professional or major curriculum in agricultural engineering have been invited to send an incoming senior and an incoming junior who are majoring in farm power and machinery, to the seminar. In addition these and other land grant schools have been invited to send one teacher or one research man from the agricultural engineering department, and one teacher in the field of farm management. The only restriction is that the individuals who attended last year are not eligible, as the program of the seminar will be much the same, and the committee wants to extend its opportunities to a new group of men.

From assembly points at Chicago, Moline, and Minneapolis the group will travel by night in chartered pullman cars, and spend daylight hours in a heavy schedule of instruction and inspection at plants of the cooperating companies in Minneapolis, Moline, Peoria, Chicago, LaPorte, and South Bend. *(Continued on page 326)*

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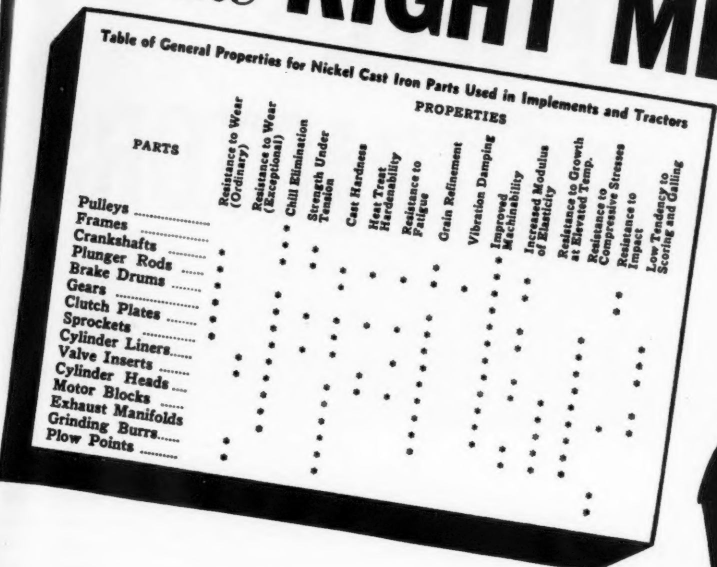


. . . these charts introduce 30

Typical Analyses of Alloy Cast Iron Implement and Tractor Parts

Applications	Total Carbon	Silicon	Nickel	Chromium	Molyb-denum	Brinell Hardness	Tensile Strength (lbs./Sq. in.)
			.25- .50				
Pulleys and Frames	3.40-3.60	2.00-2.50	.50- .80	....	....	160-180	35,000 min.
Clutch Plunger Rods	3.20-3.40	1.80-2.10	.50-1.00	....	....	160-180	35,000 min.
			.60-1.00	.25- .40	....		
Clutch Plates	3.00-3.25	1.60-2.00	.50- .80			160-200	35,000 min.
			.60- .90	.20- .35			
Brake Drums	3.00-3.25	1.60-2.00	1.00-1.50	.40- .60			
			1.25-1.75	.35- .60	.25- .45	175-225	35 to 50,000 min.
Gears and Sprockets	2.75-3.20	1.40-1.80	.40- .65	.15- .30	....		
			.75-1.25	.30- .60	....		
			1.00-1.50	.50- .80	....	175-275	35 to 60,000 min.
			1.50-2.00	....	.30- .60		
			2.00-2.50	....	....		
Cylinder Heads	3.00-3.25	1.40-1.80	.30- .60	.15- .30	....		
			.50- .80	.25- .50	....	170-200	35 to 40,000 min.
			.60-1.10	.15- .30	....		
Motor Blocks	3.00-3.25	1.40-1.80	.30- .60	.15- .30	....		
			.45- .80	.25- .40	....	170-200	35 to 40,000 min.
Exhaust Manifolds	3.00-3.25	1.40-1.80	.30- .60	.15- .30	....		
			.75-1.25	....	....	160-190	35 to 40,000 min.
Cylinder Sleeves and Liners	2.90-3.25	1.30-1.70	.50-1.00	.30- .60	....	190-260 As Cast	40 to 60,000 min.
			1.25-1.75	....	.30- .60	350-500	
			1.50-2.00	.50- .80	....	As Heat Treated	75,000 min.
Valve Inserts	2.90-3.25	1.40-1.80	.50- .80	.40- .60	....	As Cast	
			.50- .80	.30- .50	.30- .50	190-300	40 to 50,000 min.
Crankshafts	2.60-2.90	1.70-2.00	1.00-1.50	....	.70-1.00	250-290	
			1.50-2.00	....	.30- .60	As Cast	65,000 min.
			1.75-2.25	....	.40- .80	300-420	
						As Heat Treated	80,000 min.
Seed Grinding Burrs	2.75-3.25	1.00-1.50	4.50-5.25	1.50-2.00	....	*600-750	
Plow Points	3.25-3.50	.80-1.10	4.00-5.50	1.50-2.00	....	*550-750	

*Chill cast or sand cast white.

SEVEN WORDS solve most of your materials problems: "The right metal in the right place."

These two handy charts help you pick the right alloy cast iron for each point of stress or wear in your equipment. Listed at top are physical properties required by 15 vital units in tractors and implements. Analyzed above are dependable characteristics of 30 Nickel cast irons especially suited to agricultural uses.

For detailed information, write for free copy of "Implements and Tractors Use Alloy Cast Irons", an authoritative and practical paper. Simply address:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

HOW TO SELL MORE TRACTORS

Use this five-minute explanation of the strongest tractor sales point today ... a feature wanted by 7 out of every 10 farmers who have decided on the type of tractor they will buy next.

RECENTLY forty-three national and state farm papers made a survey in cooperation with the Ethyl Gasoline Corporation. Asked what type of tractor they will buy next, 7 out of every 10 farmers who had decided said, "High compression." And this despite the fact that four years ago not one tractor company in America built a high compression tractor!

Today twelve manufacturers are building high compression tractors. More high compression models are on the way.

The more clearly and simply you can demonstrate and explain a high compression tractor and why it has more power, the easier sales will be. To help you help yourself to more business, the basic engineering explanation of high compression is given here. You can read it in about five minutes. Use the information it contains to make more sales this year.

The simple truth about high compression tractors

IN recent tests, conducted at the Engineering Laboratories of the Ethyl Gasoline Corporation at San Bernardino, California, the rear-wheel power of a tractor was increased 24% by increasing the engine compression ratio, changing the intake manifold from a "hot" type to a "cold" type and changing the fuel from a good distillate to a regular-grade gasoline. Farmers who have made similar changes in their own tractors have reported even greater gains.

To understand why modern high compression, gasoline-burning tractors are more powerful than the old low compression, kerosene or distillate-burning type, consider first how any engine produces power.

How does a tractor engine produce power?

A tractor engine or any other internal combustion engine, such as that used in an automobile or truck, produces power by burning a mixture of vaporized fuel and air in the combustion chamber of each cylinder.

The force of the burned expanding mixture drives the piston down. As the piston goes down, it drives down the connecting rod, which turns the crankshaft.

The power of the revolving crankshaft is carried through the transmission and differential and converted into useful power that turns the rear wheels, or it is carried through the transmission to the belt pulley, where it becomes useful power that turns the pulley.

The *amount* of power that a tractor engine of given size will produce at a certain speed depends in general on the pressure of the burned fuel and air mixture in the cylinders.

There are two ways to increase the pressure of the burned gases in the cylinders of an engine and thus give it more power. One is to raise the compression ratio of the engine; that is, increase the compression exerted on the air-fuel mixture by the rising piston before the charge is ignited by the spark plug. The other is to let the engine breathe more air; that is, draw in a greater weight of air on each intake stroke.

How does air influence tractor power?

For every gallon of fuel burned, your tractor uses about 13 times as much air — *by weight.* You can't burn gasoline in an engine without air. The oxygen from the air unites with the gasoline to produce heat, and the heat produces power. Since the fuel in an engine must also have air in order to burn, the more air that can be taken into an engine, the more fuel can be burned to produce power.

The part gasoline's high volatility plays in increasing tractor power

An important fuel characteristic is *volatility.* In order for the oxygen in air to unite with a fuel (in burning), each tiny particle (molecule) of fuel must be brought in contact with several tiny particles (molecules) of oxygen. This is why a fuel to be burned must first be heated enough to vaporize it; so that the separate molecules are relatively far apart and each is surrounded by several molecules of oxygen. Then the two can unite very rapidly when burning is started by the spark plug.

The tendency of a fuel to change from a liquid to a vapor is termed *volatility*, and the higher the volatility the more easily the fuel will vaporize—that is, it will vaporize at lower temperatures. Gasoline has much greater volatility than kerosene or distillate. The extra heat that distillates and kerosenes need to vaporize is supplied in tractors by a hot manifold.

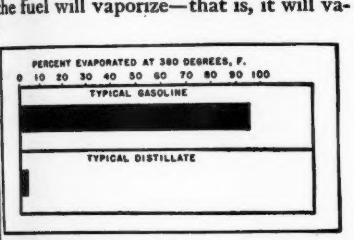


FIGURE 1. THIS CHART shows that 95% of gasoline is vaporized at 380 degrees F. Only 5% of distillate is vaporized at the same temperature.

However, heating the manifold to high temperatures to vaporize low-grade fuels reduces engine power. This is because an engine can take in only a certain *volume* of air-fuel mixture, but a given volume of cold mixture weighs more than an equal volume of hot mixture, and the *power* that is produced depends on the *weight* of mixture. Because gasoline vaporizes quickly and easily at relatively low temperatures, a cold manifold can be used, and cooler, heavier air is breathed by the engine. The result is an increase in engine power.

Gasoline gives you another advantage. It permits the use of a high compression engine, which gives you even greater power.

How does high compression increase tractor power?

To get an idea of the way high compression increases engine power, compare it to a coil spring. If we compress the spring to half its length, then release it, it rebounds with a certain force. If we compress it to a third of its length, then release it, it flies back with much greater force.

In an engine, the spring is the mixture of air and fuel. The force that compresses it is the rising piston. The ratio of the cylinder volume when the piston is at the bottom of its intake stroke and the cylinder volume when the piston is at the top of the compression stroke is known as the compression ratio. If you look at the illustration of Fig. 2, you can see just how this is measured. The higher the compression ratio, the tighter the air-fuel mixture is squeezed before burning and the more power it delivers after it has burned. Thus, if a tractor engine had a compression ratio of 4 to 1 and it was increased to 5 to 1, you would get more power out of every gallon of gasoline burned.

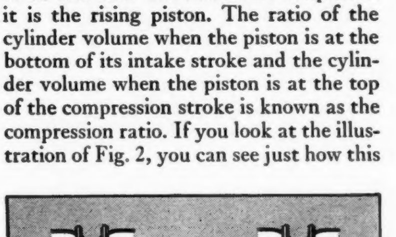


FIGURE 2. THE COMPRESSION RATIO is the ratio of the cylinder volume when the piston is at the bottom of its intake stroke and the volume when the piston is at the top of its compression stroke.

Figs. 3 and 4 show the difference between pistons and cylinder heads for high compression and low compression.

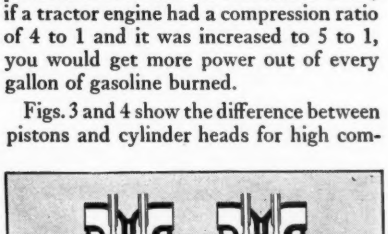


FIGURE 3. THESE DRAWINGS show the difference between a low compression piston (A) and a high compression piston (B).

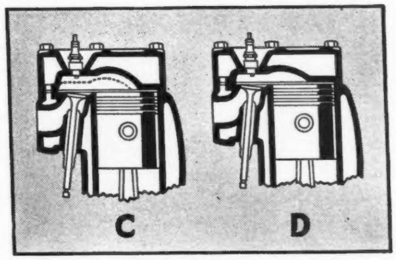


FIGURE 4. THESE DRAWINGS show the difference between a low compression cylinder head (C) and a high compression cylinder head (D). Dotted line in "C" indicates the outline of the combustion chamber with the high compression head.

In automobile engines, the compression ratios have been made higher continuously since 1925. The average has increased from 4.4 to 1 to 6.3 to 1.

The practical limit in raising compression in an engine is largely determined by the fuel used. If it is not of sufficiently high anti-knock quality, it breaks down before combustion is completed; that is, it "knocks," wasting power and overheating the motor. Kerosenes and distillates have very low anti-knock value, but fuel of high anti-knock value is universally available today, so that tractors can make use of the added power of high compression. The fuel is regular-grade gasoline (most of which contains tetraethyl lead).

* * *

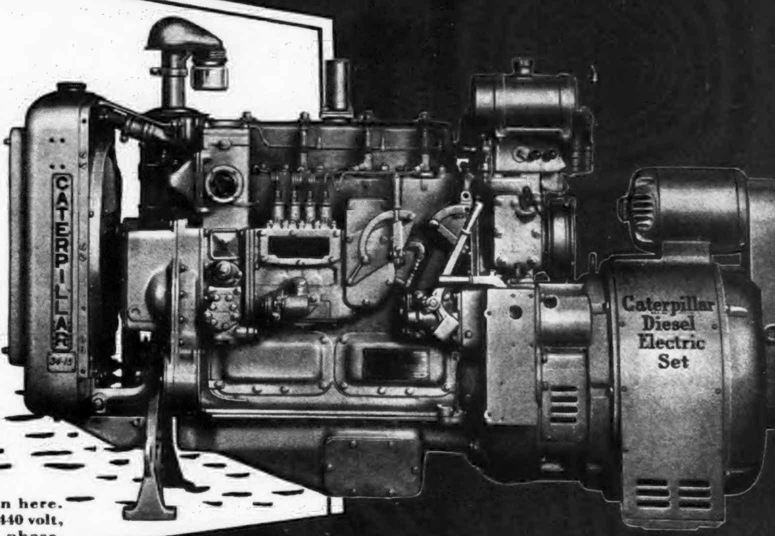
• These are the reasons why modern high compression, gasoline-burning tractors produce more power, which is the biggest reason why farmers want them. However, farmers also like to use gasoline because it gives better idling, eliminates oil dilution and eliminates the need for adjusting radiator shutters.

Offer high compression in 1939 and you'll have what 7 out of every 10 potential tractor buyers have already decided that they want.

Ethyl Gasoline Corporation, Chrysler Building, New York, N. Y., manufacturers of anti-knock fluids used by oil companies to improve gasoline.

2 NEW "CATERPILLAR" DIESEL-ELECTRIC SETS

that fit rural power needs!



The 15 K. W. Set is shown here. Generator—AC 110, 220 or 440 volt, either 3-phase or single phase.

Big news for thousands of farmers and farmer cooperatives that want dependable electric power at 1c per kilowatt hour:*

"Caterpillar" announces 2 new Diesel Electric Sets in 15 K. W. and 20 K. W. sizes—that fit a multitude of rural power needs. Constructed as units (engine and generator securely attached together) these self-contained power plants have no needless parts—are easy and inexpensive to install. Simplified design, including generators with inherent voltage regulation, leaves their operators little to do except to start and stop these sets! No switchboard nor voltage regulator is needed!

The "Caterpillar" D3400 Engine drives the 15 K. W. set; the D4400 drives the 20 K. W. These are the same responsive, heavy-duty engines that power the Diesel D2 and D4 tractors. They're built for long hours of unattended operation!

The low prices alone, on these sets (20% and more below present market!) will win them steady jobs generating power for cooperative coolers and milk plants—for crop refrigeration duty—for individual dairies and hatcheries—for neighborhood lighting projects not convenient to a high-line . . . in fact, for all electric energy uses where the services of a complete plant are most advantageous.

*Approximate—with 6c fuel at ¾-load, and including lubrication plus a fair reserve for maintenance.

Your request for further information will receive the prompt attention of "Caterpillar" Agricultural Engineers

CATERPILLAR
TRACTOR CO. · PEORIA, ILLINOIS
DIESEL ENGINES   TRACK-TYPE TRACTORS   TERRACERS

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

CONGRESS ACTS TO IMPROVE PATENT PROCEDURE

OF THE several bills introduced into Congress to improve patent procedure, as a result of testimony before the Temporary National Economic Committee, five have been passed by both the House of Representatives and the Senate. It is anticipated that they will be signed by the President promptly since the legislation proposed now has the approval of the department directly affected, the Department of Commerce. They are:

H. R. 6872—Reduction in the time allowed for public use of an invention before applying for a patent from two years to one year.

H. R. 6873—Simplification of the present interference practice, which decides which of two conflicting applications shall be granted, by referring the matter to a three-man board of interference examiners and issuing a patent immediately in consonance with their decision. Thereafter the losing party can, if he wishes, appeal the matter but the present long delay in issuance whenever such appeal is taken is eliminated.

H. R. 6874—Reduction of the time for paying the final patent fee from six to three months after notice that the application has been approved. The Commissioner is given discretion to extend this time an additional year if justification for the delay is demonstrated.

H. R. 6875—Limitation of the time for copying claims into an application from prior patents to those issued within one year, rather than two.

H. R. 6878—Reduction in the allowed time for responding to Patent Office communications from the present six months to not less than 30 days, at the discretion of the Commissioner.

At the time the above bills were before the U. S. Senate for consideration, Senator O'Mahoney presented to the Senate the recommendations of the Temporary National Economic Committee with respect to patent procedure and pointed out that H. R. 6872 was the fifth of the Temporary National Economic Committee recommendations, H.R. 6873 the third, H. R. 6874 the fourth, H. R. 6875 the sixth, and H. R. 6878, the seventh.

Two other bills are on the Senate calendar which have not yet received the approval of that body. They are:

S. 2687—Setting up a single Court of Patent Appeals to which shall be referred all appeals from decisions of U. S. District Courts regarding patent cases;

S. 2688—Termination of the life of a patent at 17 years after date of issue or 20 years after date of application, whichever is shorter.

The former has been passed over on each occasion it has been due for discussion. The latter was passed but returned to the calendar for further consideration.

H. R. 6721—Providing for reclassification of Patent Office records by a force of 25 additional examiners whose entire time shall be devoted to the task—has been passed by the House of Representatives but has not been reported by the Senate Patents Committee.

Senator O'Mahoney pointed out that "other patent recommendations made by the Temporary National Economic Committee deal rather with the uses to which patent privileges are put in the control of industry" and that "no bills had been introduced by any congressional member of the TNEC dealing with these recommendations because of the desire of TNEC that full consideration be given to the recommendations which have been made."

Dedication of Soil Conservation Service Research Project

A DEDICATION ceremony for the Hydrologic Research Project of the U. S. Soil Conservation Service at Coshocton, Ohio has been planned by the community under the leadership of the Coshocton Association of Commerce. It is to be held Thursday, August 24, beginning at 2:30 p.m. Construction of the equipment for the project is now nearing completion and a part of its research program is in progress.

In addition to the dedication ceremony which will be open to the public, and which will provide opportunity for inspection of the setup, an invitational reception and banquet will be held at 6:00 p. m.

Industry Seminar, Sept. 11 to 15

(Continued from page 320)

Six principal objectives of the seminar have been listed by the committee, as follows:

"1 To acquaint students and instructors in agricultural engineering with essential facts about the tractor and farm implement industry.

"2 To give them a better understanding of the aims, ideals, and objectives of the industry, and of its problems and its organization.

"3 To give them a wider perspective of the functions of the industry in the production, sale, and servicing of its products.

"4 To promote the friendly spirit of cooperation that exists between educational institutions and the industry through a better understanding of the industry's problems and functions.

"5 To afford an opportunity for students and instructors to obtain first-hand information on the designing of machines, selection and testing of materials, manufacturing processes, advertising, selling, financing, and distribution of machines, that they may have a better understanding the part the industry plays in modern agriculture.

"6 To give students an opportunity to study the industry from the point of view of one which may afford them employment after graduation."

ASAE Meetings Calendar

September 12-14, 1939—North Atlantic Section, Farmingdale, Long Island, New York.

December 4-8—Fall meeting, technical divisions, The Stevens, Chicago, Ill.

Personals

Kenneth R. Frost has been appointed instructor in agricultural engineering at Modesto Junior College, Modesto, Calif., having resigned as a member of the agricultural engineering staff of the University of California.

J. W. Weaver, Jr. has been appointed assistant professor of agricultural engineering at the Virginia Polytechnic Institute, effective July 1, and will be in charge of rural electrification research. He was previously connected with the agricultural engineering development division of the Tennessee Valley Authority.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Floyd W. Anderson, designer, David Bradley Mfg. Works. (Mail) 516 S. Greenwood, Kankakee, Ill.

Allyn C. Bennett, RFD No. 1, Box 65, Groesbeck, Tex.

Walter M. Carleton, rural service engineer, Kansas Power & Light Co., Abilene, Kans.

Steve Gadler, State Coordinator of Rural Electrification, State Office Building, St. Paul, Minn.

Walter E. Garrard, parts department, J. I. Case Co., Atlanta, Ga. (Mail) 450 Hopkins St., S.W.

Otto E. Griessel, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) California, Mo.

Henry K. Herlong, 132 W. Henry St., Spartanburg, S. C.

John E. Hoffman, superintendent, Deere & Mansur Works. (Mail) 2714 11th Ave., Moline, Ill.

Norman A. Hostager, fieldman, Federal Land Bank, Appleton, Minn.

H. D. Hume, president, Hume-Love Co., Garfield, Wash.

J. H. Kane, consultant in soil conservation, office of County Engineer, San Mateo County. (Mail) 1408 Mills Ave., Burlingame, Calif.

Earl M. Knepp, assistant professor of agricultural engineering, University of Tennessee Junior College, Martin, Tenn.

Ralph J. Kutchera, junior engineer trainee, Rural Electrification Administration, Washington, D. C. (Mail) 409 Peabody St.

Lloyd T. Peterson, draftsman and designing engineer, Donaldson Co. (Mail) 5100 Russell Ave., So., Minneapolis, Minn.

W. H. Tamm, research assistant, New Jersey Experiment Station, Sussex, N. J.

Joseph Weston, southwestern representative, Douglas Fir Plywood Association. (Mail) 701 Cogswell Road, El Monte, Calif.

John E. Wilson, Jr., president, Wilson Cabinet Corporation, Smyrna, Del.

Stephen R. Woods, associate professor of mathematics and industrial arts, University of Tennessee Junior College, Martin, Tenn. (Mail) 526 Lee St.

TRANSFER OF GRADE

H. Russell Tribou, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 311, Raleigh, N. C. (Junior Member to Member)

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers thereof, whose names and addresses may be obtained on request to AGRICULTURAL ENGINEERING, St. Joseph, Michigan

ENGINEERING PROPERTIES OF SOIL, *C. A. Hogentogler*, in collab. with *H. Aaron, R. C. Thoreen, E. A. Willis*, and *A. M. Wintermyer*, edited by *C. A. Hogentogler, Jr.* New York and London: McGraw-Hill Book Co., 1937, pp. XIII+434, figs. 198. The authors state that as results of road soil research became available requests for instruction in fundamentals, of which the validity had already been established practically, were met by the U. S. D. A. Bureau of Public Roads in courses given at the Bureau's subgrade-soil testing laboratory with the use of published reports of the Bureau and of cooperating agencies. This material has gradually "assumed a definite and more or less stable form, so that it can now be embodied in a textbook. . . . .

"General information on the properties of soil in relation to the design and construction of engineering work and general descriptions and the significances of the methods used in soil examination and the utilization of test results in the design of stable, durable, and economic structures are included. This material is arranged for the use of instructors in engineering materials, engineering students, and practicing engineers who desire a very general but complete conception of the physical characteristics of soils and their influence on the performance of soil as an engineering material, and also the engineer and road builder who require an intimate and comprehensive knowledge of the engineering properties of soil and tests for disclosing them." Soil dynamics research in progress for about 20 yr at the Alabama Experiment Station is not mentioned, however.

The contents are an introduction; in part 1, on the origin and composition of soil, soil constituents, soil mixtures, and natural soil formations; in part 2, on the characteristics of soil, colloidal surface phenomena, the character of soil moisture, movements of soil moisture, and frost phenomena; in part 3, on the structural properties of soil, the pressure bulb, settlement due to compression, and shear strength and stability; and, in part 4, on the practical design and construction, classification of soils for engineering purposes, design of graded mixtures, stabilization of fine-grained soils, construction of stabilized-soil roads, soft foundation soils, properties and performance of typical soils, and miscellaneous properties and tests; also appendixes (1) conversion tables, (2) nomenclature, (3) glossary of geological terms, and (4) terms identifying soils in the profile; a bibliography; and a general index.

AIR CONDITIONING: INSULATION, *J. R. Dalzell* and *J. McKinney*. Chicago: Amer. Tech. Soc., 1937, pp. [8]+301, [pls. 5], figs. 136. The properties of various types of insulating materials are dealt with, data compiled from reports of the American Society of Heating and Ventilating Engineers and other standard sources being included, together with detailed descriptions of numerous specific commercial brands of insulating materials. The construction of various types of insulated walls and the application of insulation to roofs, in floors, and about heating appliances, pipes, and air ducts is also taken up and illustrated by drawings and photographs.

The book contains the following sections: Introduction, physics of insulation, kinds of insulation, where insulation is used, transmission coefficients and tables, heating and cooling loads, tables and coefficients, glossary of terms, and design of insulation, together with an index and a psychrometric chart.

AGRICULTURAL ENGINEERING AT THE ARKANSAS STATION. Arkansas Sta. Bul. 368 (1938), pp. 13-17, 61, figs. 2. Data on supply, requirement, and rainfall contribution in the irrigation of rice, by D. G. Carter and K. Engler; on physical and economic inputs for field power, by W. C. Hulburt and O. J. Hall; on farm building construction costs and on a study of rural housing, both by Carter; and on the influence of poultry housing on egg production, by Carter, R. M. Smith, and W. H. Wiley, are stated briefly and discussed.

AGRICULTURAL ENGINEERING AT THE COLORADO STATION. Colorado Sta. Rpt. 1938, pp. 22, 23, 36-39. The civil engineering section reports on studies of seal coats for bituminous surfaces and on bond strength and anchorage given by cold-drawn wire reinforcement in concrete. The mechanical engineering section (cooperating with U. S. D. A.) reports on sugar beet machinery, including tests showing improved results (as compared with placing the fertilizer with the seed or broadcasting it) when the fertilizer was mechanically placed below and close to the seed; easier irrigation of ridge-planted beets as compared with flat-planted beets, with no difference in yield between the two methods; tests showing from 16 to 40 per cent better germination following the disk opener as compared with the shoe-type opener; and very promising trials of a single seed-ball planter. The irrigation investigations section reports upon an adjustable tube orifice meter; a new summation recorder for acre-feet which indicates also the stage in feet and corresponding second-feet discharge when used in conjunction with a Parshall measuring flume, stable rating flume, or free-flow weir; study of a vortex tube sand trap; and work on a new sand trap. The report also notes an increasing use of the Parshall measuring flume in irrigation and its adaptation to sanitation engineering, possibility of lining lateral irrigation ditches with asphalt and cotton fabric to reduce seepage, snow survey and irrigation forecasts, work on irrigation pumping, meteorology, and supplemental irrigation.

AGRICULTURAL ENGINEERING AT THE KANSAS STATION. Kansas Sta. Bien. Rpt. 1937-38, pp. 127-129. The report contains brief notes on machinery improvement and agricultural engineering and milling industry, both by L. C. Aicher; dry-land agriculture, by F. A. Wagner, A. E. Lowe, and H. J. Haas; and irrigation agriculture, by Wagner and Lowe.

A SEPTIC TANK DISPOSAL SYSTEM, *E. R. Gross*. New Jersey Stas. Circ. 381 (1938), pp. 19, figs. 18. This circular gives full directions in nontechnical language for the construction of cement tanks of the one- and two-chamber types (the latter being preferred), together with all necessary connections and absorption areas of two loops of porous tile to be laid out either in level ground or on the contour of sloping land. The system described includes a diversion gate permitting the alternate use of the two loops of absorption areatiling. Adequately dimensioned plan, section, and elevation drawings and material specifications are provided, and suitable cement mix proportions are given.

SOME ENGINEERING ASPECTS OF LOCKER AND HOME COLD STORAGE PLANTS, *W. H. Martin*. Oreg. Engin. Expt. Sta. Circ. 4 (1938), pp. 18, figs. 5. This is a discussion of the refrigerating plant and its adaptation to locker storage. Information also is given on a small combined freezer and storage.

REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ENGINEERING, 1938, *S. H. McCrory*. U. S. Dept. Agr., Bur. Agr. Engin. Rpt., 1938, pp. 26. Data from the Division of Farm Structures are given on farm building insulation; farm storage of potatoes, corn, and other commodities; refrigerator car studies; pressure of silage crops; and orchard heating. The Division of Drainage gives data on hydraulic studies, run-off investigations, drainage of timberlands, durability of drain tile, effect of silage acids on concrete silos, irrigation of strawberries, drainage of sugarcane lands, water control in peat and muck soils of Florida, C. C. C. drainage camps, maintenance of drainage channels, and flow of water in drainage channels. The Division of Irrigation notes studies on irrigation of subtropical fruit and pears, duty of water, evaporation, and snow surveys and irrigation water supply forecasting. The Division of Mechanical Equipment reports upon fertilizer-distributing, corn production, sugar beet production, and cotton production machinery; moldboard-plow bottoms and disk-harrow blades; harvesting and drying pyrethrum; harvesting sweet potatoes for starch; corn-borer control equipment; and the mechanical harvesting of cotton. The cotton ginning investigations of the Bureau have included work on simplification of gins, new developments in cotton driers, fan and piping tests, and gin capacity studies. The report also contains brief statements concerning farm operating efficiency investigations. *(Continued on page 332)*

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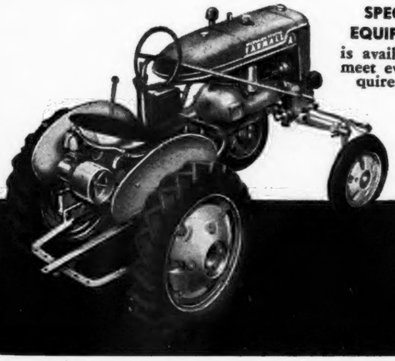

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Agricultural Engineering Digest

(Continued from page 328)

Agricultural Engineering Investigations by the Wisconsin Station, Wisconsin Sta. Bul. 442 (1938), pp. 26-31, 41-47, figs. 3. Progress results are briefly presented of investigations on erosion control, by H. O. and D. Anderson, D. M. Keyes, and P. E. McNall (cooperative with the U. S. Department of Agriculture); development of new equipment for making alfalfa silage, by F. W. Duffee and H. D. Bruhn; ventilation equipment for chopped hay, by Duffee, Bruhn, L. F. Graber, G. Bohstedt, B. H. Roche, and E. B. Hart; drying grain in windrows before combining, by Duffee and Bruhn; rotary sprinkler irrigation, by Duffee, Bruhn, and H. L. Ahlgren; and sealing of wells, by Duffee.

Literature Received

"Rural Water Supply and Sanitation," by Forrest B. Wright. XX + 288 pages, 5½x8 in, clothbound. This is a text and reference presenting practical information on the subject for farmers, rural home owners, and agricultural students. Part I includes specific instructions on how to do each of twenty-four elementary plumbing jobs. Part II includes chapters on the nature and sources of water, pump principles and types, types of water systems, typical installations of gravity and hydropneumatic systems, problems of installation of water systems, farm plumbing systems, and farm sewage-disposal systems. Convenient tables, bibliography, and index. John Wiley and Sons, Inc., $2.50.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

SENIOR ENGINEER, ENGINEER, ASSOCIATE ENGINEER, AND ASSISTANT ENGINEER. The U. S. Civil Service Commission announces an unassembled open competitive examination for engineers in various branches in the above grades. Applications must be on file with the Commission at Washington, D. C., not later than August 14, 1939, or for those mailed from any of several named states in the far West, August 17. Application form 8, copies of which may be obtained at any first-class post office, should be used in filing application for this examination. Applicants must have successfully completed a full four-year course leading to a bachelor's degree in engineering or show acceptable substitute experience, and in addition must meet stated minimum experience requirements. Other usual Civil Service examination regulations apply. More detailed information is given in the Commission's announcement No. 67 dated July 17, 1939.

AGRICULTURAL ENGINEER with a degree and with experience either in teaching or shop work wanted to fill an assistanceship in farm shop starting September 1. The work will consist of general farm shop and assisting in one class of farm machinery. The farm shop work will include such activities as forge, welding, lathe work, tool fitting, as well as farm machinery shop, both field machinery and motors. Present classification for the position is $1800.00 with increments of $150 per year up to $2600, but it is anticipated that before the maximum is reached the classification will be considerably increased. PO-124

POSITIONS WANTED

AGRICULTURAL ENGINEER with bachelor's degree and a farm background, desires sales, education or demonstrational work. Has one year's experience with the sales and service branch of a large farm machinery company, and four years' experience as assistant county agricultural agent in soil conservation and engineer in charge of a large terracing unit. Has had considerable experience in contacting farmers and helping to solve their problems. Has a real sales record. Age 39. Married. PW-305

AGRICULTURAL ENGINEER, 1938 graduate with bachelor's degree and with some experience in reasearch work, desires position in engineering research or in production management and time study. Age 24. PW-306